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REPORT NO. 2413-1-76

DEVELOPMENT OF AN AUDIO-TACTILE SIGNAL

TO ASSIST

BLIND AT PEDESTRIAN CROSSINGS

The Research Project was
Sponsored by:

Australian Department of Transport

N.S.W. Department of Main Roads

30th June, 1976.

DEPARTMENT OF MAIN ROADS, N. S. W.

TRAFFIC SERVICE SECTION

Development of an audio-tactile signal to assist the blind at pedestrian crossings

FOREWORD

Over the last few years there has been an increasing recognition of the need to investigate the requirements for a non-visual traffic signal to supplement the existing pedestrian light signals. Whilst the need is based primarily on the demands of the visually handicapped pedestrian, there is evidence that an audible signal would also benefit the general pedestrian public.

Following experience with some earlier, primitive experimental (audible and tactile) signal devices, a thorough investigation was carried out to determine the requirements for a suitable system. To this end a questionnaire survey was carried out of the registered blind population of New South Wales, supplemented by a literature search and a world-wide survey of signal devices and practices developed elsewhere. The results of these surveys and searches, together with the subsequent theoretical analysis, were presented in a technical paper "Traffic Signal Facilities for Blind Pedestrians" presented at the 8th Conference of the Australian Road Research Board (Perth, 23rd to 27th August, 1976). The material contained in that paper comprised the terms of reference for this report which covers the practical aspects of the research.

As Project Manager of this second and practical stage of the investigation, I am pleased to present this comprehensive report, prepared under contract for the N. S. W. Government by Louis A. Challis and Associates Pty. Ltd., Consulting Acoustical and Vibration Engineers. Whilst the report concludes with firm recommendations and constructional details of the audio-tactile signal device developed in this project, I would caution that field trials on the new signals have not yet been carried out. Accordingly, the information in this report, whilst available to others without reservation, must be treated as preliminary data on a device the field performance of which is yet to be proven.

Arrangements are in hand to manufacture eight sets of the new audio-tactile signal and it is proposed to install these at the intersection of Burwood Road and Railway Parade, Burwood. This site is frequented by many blind people visiting both the Royal Blind Society of N. S. W. and the Association of Blind Citizens of N. S. W. As it is also representative of busy urban intersections and has high levels of ambient noise from busy vehicular and rail traffic,. it will be a good site at which to test the new device. Comments will be sought from the abovementioned two organisations at the end of a six months trial period, as to the feelings of their respective members. At the same time, the reaction of sighted pedestrians to the supplementary audible signal will be studied and the effectiveness of the automatic volume control facility will be evaluated in terms of community annoyance to the surrounding residents and local businessmen.

I should add, by way of explanation, that the investigations were commenced by the Department of Motor Transport, N. S. W. However, the project became the responsibility of the Department of Main Roads, N. S. W. after 30th June, 1976, when the traffic signal functions in this State were transferred to the latter Department under the provisions of the Traffic Authority Act, 1976.

Frank R. Hulscher.

(F.R. Hulscher)
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2nd November, 1976

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SUMMARY

This report presents the results of a research project whose aim was to investigate, research and develop an audible signal to assist blind pedestrians to more safely cross the road at pedestrian crossings fitted with traffic lights.

What has been researched and produced is an audio-tactile signal suitable for use by both the blind and sighted pedestrians at traffic light controlled intersections and which makes use of existing pedestrian crossing hardware to produce an effective signal to aid sighted and blind pedestrians as well as blind pedestrians suffering from a significant hearing disability.

PERSONNEL

This report has been produced by a co-operative effort from a number of staff members of Louis A. Challis and Associates Pty. Ltd. The personnel involved in order of involvement and input are listed hereunder:

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1. INTRODUCTION

In today's world there are certain standards of performance which are unwittingly set by the majority of the population. The minority who cannot, rather than will not, attain these standards are classified as physically handicapped. These 'handicaps' are present in several forms and one of the better known is the visual type. A visual handicap or blindness can be present by itself or in conjunction with other forms of physical handicap.

The modern day society shows a sympathetic attitude for the blind minority. The common "feeling sorry" attitude towards the blind is expressed either vocally, physically, financially or a combination of these culminating in the availability of special facilities and aids which will help the blind to overcome their handicap.

A blind person is reminded of his handicap when he cannot readily attain goals which he himself or others set for him. This situation in general is aggravated by the unfamiliarity and/or unpredictability of the environment as is the case of a blind pedestrian attempting to cross a road. Negotiating an intersection in an unfamiliar area is almost an impossible task. The installation of traffic control lights at intersections together with special facilities for blind pedestrians can overcome some of the problems.

In Australia and overseas several different types of devices and facilities are available to help blind pedestrians at traffic light controlled intersections. These vary from a simple device to the more sophisticated systems with both practical as well as novel ideas.

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Most of these devices were commissioned with a minimum of preliminary research to establish their suitability or even practicability. The uncoordinated attempts to provide special facilities at traffic light controlled intersections have resulted in at least partial if not total failure for some of the units developed. This has resulted in a feeling of mistrust towards these facilities by the blind and lack of acceptance by environmentalists.

This feeling was summarised in the concluding stages of the 34th Annual Convention of the U.S. National Federation of the Blind 1974[3], where a resolution was passed that *"opposition would be voiced against any projects aimed at assisting the blind in their mobility which cannot be shown to be of real use or benefit"*. It was resolved that aids or facilities to benefit the blind should not be such as to unduly categorise this group, set unrealistic standards or be produced without full consultation with organisations of blind people.

An in-depth investigation conducted by Motor Transport Department of N.S.W.[34] highlighted the extent of the problems encountered by the blind population at traffic light controlled intersections. This investigation revealed the extent of overseas research into the problems and showed the need for further research into the problems encountered by the local blind population.

A questionnaire survey of the local blind population provided useful quantitative data as well as direct feedback from the blind on their need for special facilities at intersections. The overall investigation culminated in a set of guidelines for future local research which was then commissioned under the combined sponsorship of the Australian Government and the N.S.W. Government under the provisions of the *Transport*

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(Planning and Research) Act 1974. The research project was then commenced under broad guidelines with regular discussion and evaluation meetings by a specially formed interdisciplinary panel from relevant organisations. The initial guidelines were:-

(1) To conduct a literature and instrumentation investigation of the acoustical vibration characteristics of those audible and tactile signals currently in use in Australia and elsewhere in the world. This investigation would allow a determination of these signals' characteristics which statistically best meet the criteria of acceptability or unacceptability determined from a series of laboratory and field investigations conducted with a group of blind pedestrians.

(2) Develop a number of simple models for further evaluation by the blind sample group to determine which of these audible signals most nearly meet the optimum characteristics of audibility, directional localisation, and if possible tactile performance.

(3) Construct a prototype to provide audible discrimination of the present traffic light controlled systems by a simple pulse or pitch coding system. This would be initially installed under laboratory conditions where its performance would be assessed under artificially reproduced traffic noise conditions in a reverberant environment.

(4) Determine the overall subjective response of a sample group of blind as well as sighted people to several artificially produced sounds initially and subsequently evaluate their response to a working prototype device

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which can then be developed as a complete system.

(5) Document the overall results of the investigation and present a prototype system for installation and further evaluation.

2. LOCAL AND OVERSEAS EXPERIENCE

In Australia there is no current national policy on the requirements of special facilities for blind pedestrians at traffic light controlled intersections. This has resulted in individual representations by interested organisations with varying results. The initial installations were based on bells, buzzers and beepers.

In Melbourne buzzers were initially installed and subsequently followed by a Piezo-electric "beep" device which emitted a higher frequency signal. Both of these devices have poor localisation qualities and only provided a simple auditry cue during the walk intervals. The availability of more modern electro-mechanical devices prompted the issue of new specifications which not only provided an audible signal but had good localisation and some vibro-tactile characteristics.

In Adelaide the initial experimentation was confined to vibro-tactile signals which were made from a modified form of an electro-magnetic device. This provided a vibration signal of a special button as well as an audible "buzz" during the "walk" period.

In Sydney an attempt was made to differentiate the crossing interval across two streets at an intersection by using bells and buzzers. This system was purely auditry and had to

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be removed as a result of complaints of noise annoyance and regular failures. The next attempt was to install a vibro-tactile device which has passed several stages of improvement but still receives criticism from the blind people using it.

In Brisbane vibro-tactile devices were rejected and a purely auditorysignalling system was installed. This system incorporated loudspeaker horns fed by a purely electronic signal in the frequency region of 300Hz. This system sounded continuously during the "walk" period and intermittently over the clearance interval. The system basically requires the blind pedestrian to activate a special switch and hence requires preliminary familiarisation for effective use. All the attempts at providing special facilities for the blind in Australia have either been based on an easily generated signal or a simple vibratory signal as a result of the experience gained from the installation of these devices.

The current trend is towards recognising the need for providing an acoustical as well as vibro-tactile system and only recently has a viable system been made available which provided the basis of the new specifications laid down in Melbourne. This device is a mechanical ticking system currently available from Sweden.

The major work associated with special facilities for blind pedestrians at traffic light controlled intersections appears to have originated in both Sweden and Japan. In Sweden a system was developed based on a simple principle of an electro-magnetic relay tapping against a metal case. This system overcame many of the faults of previous systems as well as incorporating several desirable features. This

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system which we will call the "ticker" emits a mechanical clicking sound with relatively high transient content, broad frequency spectrum and short duration. All these features help in localisation, detection amongst traffic noise and least annoyance to the community. The bonus feature of this device is the vibro-tactile signal which can readily be felt when the unit is operating. The unit is also designed to be used as a pedestrian push button and hence it is a total system rather than a "tack-on" type.

In Japan a major effort appears to have been directed towards providing a system which overcomes the difficulties and criticisms of other systems encountered throughout the world. The result of this work was to produce audible devices which emitted an electronically produced bird sound or musical tunes which presumably were meant to minimise the problem of noise annoyance. This resulted in a large number of different type of bird sounds being emitted throughout Japan and whilst possibly providing a natural environment, would produce extreme confusion to a blind person away from home. The Japanese authorities have now attempted to co-ordinate and standardise their auditry signals which to date have been the sole responsibility of Metropolitan and Prefectural Authorities.

The Japanese vibro-tactile system provides a strong vibratory signal over a large surface when activated. This overcomes the problem of having blind pedestrians waiting their turn to touch the vibrating signal which in the past has only been in the form of a small button adjacent to the normal pedestrian push button. This is designed to be mounted clear of obstructions and in the middle of a series of special plastic tiles with a raised surface which would help the blind pedestrian locate the post and also follow a pre-determined path across the road.

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In New Zealand a new type of tactile device was tried where a plunger emerged to signify the "walk" period but this did not prove very successful.

In both England and New Zealand a national policy has been formulated with respect to providing special facilities for blind pedestrians and hence some form of standardisation has been accomplished. In the main, these devices have been installed only at selected pedestrian locations where no conflict between pedestrians and traffic flow exists.

Only in a few cases have special facilities been provided at the more complex intersections involving parallel movements of pedestrians and traffic. In these cases two types of signals such as bells and buzzers have been used to signify the "walk" interval in the two opposing directions. In one instance the same sound was used at this type of intersection and the difference between the opposing directions signified by a continuous and intermittent sound. This can be taken to the extreme in the case where a multitude of signals are available such as those utilised in Japan.

A further development to the types of audible devices is a system using frequency scanning with variations in scanning rate and mark space ratios. In all of these instances attempts at improving existing installations has been a prime consideration and the poor directional qualities of the Piezo-Electric devices operating at 2,800Hz have been improved by utilising signals producing transient sounds such as the Swedish "ticker". The use of both bells and buzzers has not proved very successful andhence their use has not been developed further.

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The use of musical tunes and bird sounds has not significantly improved the localisation characteristics of existing systems and their only merit is the variety of sounds available and their blending with the surrounding environment. A fairly extensive research programme was carried out in Denmark[2] which resulted in optimising the frequency of the acoustic signal and producing a directional sound beacon over a crossing. This system was uni-directional and hence only pedestrians on one side of the intersection were provided with a signal during a "walk" interval. This approach of beaming the sound across an intersection involves use of overhead loudspeakers and hence does not fully resolve the problems of poor localisation of audible sounds. The use of speech signals have also been experimented with in both America and Japan but these have not been considered successful.

The only other approach to overcome localisation difficulties has been the Japanese system of "braile tiles" which can be felt by pedestrians walking over them. The raised surface of these "braile tiles" may be awkward to walk on and could even result in a trip hazard to pedestrians.

The use of vibro-tactile devices to indicate the crossing interval across one direction of an intersection is a more positive form of localisation which cannot be easily confused. Even though this device identifies the intersection it is very difficult to locate without the use of "braile tiles" or a supplementary audible system. Some audible signal devices are capable of producing a vibro-tactile signal and by the same principle some vibro-tactile devices are capable of producing audible signals.

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The Japanese vibrating touch post is virtually a vibro-tactile device which produces no audible sound even when energised. The Swedish "ticker" however is energised for both the "dont walk" and "walk" periods at different rates and hence an audible as well as vibro-tactile signal is available at all times. This allows a unit to be located by an approaching blind pedestrian and once located gives easy identification of the "walk" period in the required direction.

None of the other devices currently installed have all the advantages of the Swedish "ticker" without producing added disadvantages. More recent studies into the problems of providing special facilities for blind pedestrians have been directed towards developing an improved sound signal which satisfies the basic criteria for a sound signal at a traffic intersection.These criteria requires the sound to be easily located and detected above traffic noise, simple to produce, install and maintain whilst at the same time producing minimum noise annoyance.

The latest research has in the main been based on determining the ideal frequency to satisfy the above criteria. No in-depth study into varying time history or harmonic content of a signal appears to have been reported. The selection of an ideal frequency must be related to the time history of that signal in terms of repetition rate, mark space ratio, and rise and fall time. Research into an ideal vibro-tactile signal has not been extensive and basic data on fingertip sensitivity of the human body is only just being collated.[1,29,35]

A review of the problems encountered with currently installed audible and vibro-tactile devices,[34] together with available research into their development, has shown a strong preference for an audible device with some vibro-tactile qualities.[36]

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A recent survey in Australia[34] has also shown preference for an audible signal but the results are heavily dependent on previous experience with audible and/or tactile signals. The results also show the reluctance of blind people to trust either an audible or vibratory signal.

3. DEVELOPMENT OF CRITERIA

A study of research[15] into the problems of providing an audible and/or vibro-tactile signalling system for blind pedestrians has shown that several conclusions can be arrived at. It has been shown that an optimised frequency is 880Hz whilst the frequency range between 1.5kHz and 2.5kHz should not be used because of poor localisation. These results are based on tests conducted with pure tones which in themselves are not typically every day type sounds. Pure tones also confuse the human auditry system and do not make full use of the ear's capability of differentiating phase as well as time delay.

The time delay detection function can be overcome in part in a non-reverberant condition where binaural hearing allows the localisation of pure tones. In a semi-reverberant condition localisation is best established by the pinna effect[21] which utilises the transient nature of available sounds for localisation. In general the environment associated with a typical road intersection is of a semi-reverberant nature and only rarely does a true non-reverberant condition exists. A criterionfor a sound signal must be based on a varying signal either in the frequency or time domain with possible transient characteristics.

This broad criterionwas further supplemented by local constraints[33] such as ease of generation, economical to produce, reliability, readily installed at existing traffic light controlled intersections.

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A range of model sounds were developed based on the broad criteria for a sound suitable to be used as an audible signal at traffic light controlled intersections. These model sounds were based on the following:-

Frequency
The frequencies selected were 300Hz, 500Hz, 800Hz, 1kHz and 2kHz.

Repetition Rates and Duration
These frequencies were then presented as tone bursts with repetition rates of 20 per second, 10 per second, 1 per second, 1 every 1½ seconds and 1 ever 2 seconds, with on-times varying between 10 milliseconds and 100 milliseconds.

Envelope Shape
The signals were also passed through an envelope shaping network which produced exponentially rising and exponentially decaying sounds as well as the normal constant width pulses.

Frequency Sweep
The signals were also produced by combining a frequency sweep from 300Hz to 2kHz and from 2kHz down to 300Hz with the previously used repetition rates and duration.

Harmonic Content
Signals used were either sine wave or square wave as these two were the easiest to produce and typified the purest and least harmonically pure signals respectively.

The model sounds developed were then presented in a logical fashion to the evaluation panel with specific interests in the field of traffic control and mobility aids for the blind. At an early stage in the evaluation it became apparent that certain specific combinations of the above variables would be unsuitable. On a purely subjective basis it was found

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that square waves were more readily detected than sine waves because of harmonic content, with a suitable basic signal frequency being in the range 500Hz to 1kHz. This frequency range would provide ease of detection above traffic noise and still maintain reasonable localisation characteristics. Suitable repetition rates for locating signals were found to be between 1½ seconds and 2 seconds based on minimum annoyance whilst still maintaining reasonable continuity. A suitable duration was found to be between 25 and 50 milliseconds for tone bursts of sound and still maintain reasonable frequency content.

For the "walk" signal it was found that similar comments applied to those listed above except that the repetition rate had to be increased to approximately 10 per second. All signals which utilised frequency modulation or frequency sweep were found to be alienated because of their similarity with existing emergency sirens and were rejected on that basis. Envelope shaping in the form of exponentially decaying sounds was found to be very readily attained and were also found to have suitable acoustic qualities to warrant their further investigation.

As a result of detailed evaluation and discussion of these model sounds, a series of prototype sounds were then developed for laboratory evaluation with sample groups of blind as well as sighted subjects. The prototype sounds were in the form of the series of "dont walk" and "walk" signals in sequence.

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4. PEDESTRIAN CROSSING SIGNALS IN N.S.W.

The current practice in N.S.W. for pedestrian crossing facilities utilises a "press to walk" push button located in a die cast aluminium box located approximately one metre above ground level. The present trend is towards giving a "walk" signal only on demand as indicated by the operation of the push button. The push button housing must not be exposed to voltages in excess of 32 Volts AC and must be vandal proof (i.e. be capable of withstanding the half-brick test). These requirements allowed us to specify physical dimensions, available power and ruggedness as part of the original criteria.

The next step was to survey available electro-acoustic transducers based on the premise that an acoustical signal is preferred. Loudspeakers commonly available would require substantial protection to be vandal proof and if mounted inside a heavy metal box they would require perforations which can easily be blocked if not in fact used as entry points which would result in speaker damage. An overhead mounted horn speaker system overcomes some of these problems but still leaves itself exposed to enterprising vandals who may require a horn speaker.

Over the past few years several manufacturers have produced electro-magnetic transducers which were designed to be screw fixed to some form of sounding board (i.e. ceiling and walls) and hence form an electro-acoustic system. The use of this type of transducer can overcome many of the problems of loud speakers (Hi Fi Review - Vol. 2 No. 7, pp 64-65) and hence further work was commenced in producing a working prototype using a typical transducer.

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A preliminary prototype was produced incorporating a transducer physically mounted inside a normal pedestrian push button "press to walk" box. The transducer which was resiliently mounted inside the box, was then physically coupled to the front escutcheon plate which then acted as a diaphragm for the electro-acoustic transducer. Our work was then concentrated on narrowing the available choice of sounds which used this transducer and could be incorporated at traffic light controlled intersections.

5. INITIAL LABORATORY PHYSCHO ACOUSTICAL INVESTIGATIONS

The range ofsounds were now limited to four (4) types; i.e. a tone burst square wave with a basic frequency of 1kHz and 25 milliseconds duration; a tone burst sine wave with a basic frequency of 1kHz and 25 milliseconds duration; a tone burst square wave with a basic frequency of 500Hz and 25 millseconds duration; and, an exponentially decaying sine wave with a basic frequency of 500Hz and 50 milliseconds duration.

These sounds allowed evaluation of preference of sine versus square wave, high or low frequency, square wave tone burst or exponentially decaying signal. These sounds also fell within the constraints of the criteria as set out in Section 3 above. A favourable reaction has been obtained to date on a Swedish device that produces a mechanical ticking sound and hence this sound was included with the above four types in the proposed subjective evaluation tests.

The test session was conducted in the theatre of Anzac House which is equipped with a system for audience subjective evaluation tests for T.V. commercials and pilot films. This equipment is owned and operated by Audience Studies Incorporated who regularly conduct these tests and who were

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retained to assist in conducting the evaluations. The test session involves supplying each person of the audience with a control box fitted with a pointer. The audience is then instructed to consider the control position as normal and move the pointer to the right for positive reactions and to the left for negative reactions. The output of each control box is fed to a special purpose analogue computer which is programmed to scan the audience responses and sum the reactions according to the desired audience grouping. The results are then plotted on a chart recorder for analysis and data reduction.

For our test session a very broad sample group of people were carefully selected and transported to the theatre. The grouping selected included blind as well as sighted people with and without hearing defects. This allowed four distinct sample groups to be isolated and the performance of each group was then evaluated. The test session was divided into four distinct categories whilst each category was also sub-divided.

The sequence of steps used for a typical test was to present the first "dont walk" signal at a fixed audible level. The audience was then asked to firstly indicate their degree of like or dislike of the signal. The same signal was then presented at three different levels which were respectively -10, 0 and +10dB with respect to the L_{90} (where L_{90} indicates the noise level exceeded for 90% of the time) level of traffic noise which was simultaneously played in the background. The subjects had to indicate with their control knob at what point in time that they heard the sound. Thistest sequence was carried out for all five "dont walk" signals. The period of each "dont walk" signal was 30 seconds. At the end of this test all five signals were played

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consecutively and the subjects were asked to indicate their preference between each of the five signals.

A similar test sequence was then conducted on "walk" signals which were the same type of signal as the "dont walk" signal except played at a repetition rate of 10 per second and a duration of 10 seconds each to simulate the short duration of the "walk" signal in a real life situation.

The next test consisted of presenting the "dont walk" signals in a two cycle sequence of 20 seconds and 10 seconds respectively. This test sequence was carried out for three types of signals and at three levels similar to the first two tests in the presence of traffic noise. The purpose of this test was to determine the audience's ability to discriminate between "walk" and "dont walk" signals presented. The three signals were the mechanical ticking sound, the 1kHz square wave tone burst and the 500Hz exponentially decaying sine wave.

The final test sequence consisted of using the first three sounds but in this instance the "dont walk" version of the signal was reproduced at the front of the stage with the signal source changing from the left hand side speakers to the right hand side speakers. The signal lasted for a duration of 10 seconds on each side over two cycles. These signals were also presented at three levels as before in the presence of traffic noise.

The data obtained from this test was obtained in the form of a set of chart recordings. These charts were divided to present the results for the four individual sample groups plus a master chart. The pens on the chart were adjusted to normalise all subjects'control boxes to the mid-point

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position and thus negative and positive reactions to the signals presented were obtained as variations on the chart around the normal mid-point position.

The experimental data was reduced into a graphical format and conclusions were then drawn. The test session analysis indicated a definite preference for the 1kHz square wave tone burst as a "dont walk" signal based on good audibility in traffic noise, good localisation characteristics and a strong audience appeal. The 500Hz exponentially decaying sine wave signal at the fast repetition rate was selected as the "walk" signal. This selection was based on good audibility in the presence of traffic noise, preference by the test groups, as well as being significantly different from the "dont walk" signal to allow good discrimination. It was also found that this type of signal produced the highest vibro-tactile sensation when coupled up to our prototype pedestrian "press to walk" button fitted with an electro-acoustic transducer.

6. PRODUCTION OF A WORKING PROTOTYPE

The signals selected for the "dont walk" and "walk" sequence were then produced as two working electronic circuit boards, one for each signal. These boards were wired up via a switching network to allow two prototype pedestrian "press to walk" push buttons to be used simultaneously. The switching arrangement allowed both push buttons to operate in the "dont walk" mode and also to operate individually in the "walk" mode. These prototype boxes were then mounted on two special traffic poles, and used in a field test conducted to evaluate each selected sound in a realistic test situation.

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These tests were conducted in the premises of the Royal Blind Society of N.S.W. where the two posts were placed approximately four metres apart to represent a typical installation on one corner of an intersection.

A thorough analysis of the results of this test indicates a pronounced mistrust of mechanical aids by blind pedestrians at traffic light controlled intersections. This mistrust was based on the experiences gained from currently installed vibrating signals. In general, the unsolicited comments obtained at the end of each test highlighted several problem areas; the uncertainty of the remaining duration of the "walk" signal, apprehensions as to the possible detection of this signal above traffic noise; and the problem of locating a pedestrian push button when two "dont walk" signals are present simultaneously. A favourable reaction was obtained to having a combined audible as well as vibro-tactile signal with the occasional comment that"one would reinforce the other if a failure occurred" *(which is obviously incorrect).*

Questioning as to the suitability of the selected "dont walk" and "walk" signals in terms of frequency and repetition rate further supported the results of the previous laboratory investigation. Problems encountered during these tests by hearing aid users cannot be readily resolved and hence can only be highlighted at this time. The problem of locating the required signal with more than one present would be overcome by the blind pedestrian using other available cues to head towards the required traffic light pole until a clearly distinguishable signal from that pole is heard.

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The blind subjects were asked to approach the imaginary street intersection, select the pedestrian push button for the straight ahead crossing and ignore the push button for the left hand side of the corner which was represented by the other pedestrian push button.

The subjects were also asked to point directly to the pole mounted with the "dont walk" sound at the completion of their test and in general they succeeded in this task with reasonable accuracy.

This test involved the subject starting at approximately seven metres from the imaginary intersection. Initially they had to walk past the pedestrian push button for the left hand pedestrian crossing and locate the push button for the straight ahead pedestrian crossing. Then they had to wait at this push button until a "walk" signal occurred and then move forward. The subjects' unsolicited comments were then tape recorded and further information was also obtained by direct questioning of the subject. During each of these tests a background masking noise was played. This noise consisted of pink noise with a frequency weighting similar to typical street traffic noise. This noise was selected in preference to actual traffic noise to overcome any false reactions which may have resulted from the blind people's cueing their reactions from the recorded traffic noise.

In general, all the blind subjects found the correct post and responded correctly to the "walk" signal on that post only. Two problems did arise, firstly with a blind subject wearing two hearing aids, which resulted in a total loss of directional characteristics and secondly with another subject who relied heavily on his guide dog. This subject instructed his dog to

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find the pole and the dog located the wrong pole to start with and secondly circumnavigated the correct pole because of his fear of the background noise being generated between the two poles on a tape recorder to represent traffic.

This subject did, in fact, override his dog in the second test and found the pole by himself. The general comments indicated a very favourable reaction to both signals with the occasional comment regarding the annoyance of the "dont walk" signal. One subject also mentioned that the "walk" signal could be confused with a compressor on a refrigeration truck or a jack hammer if one was operating in the area.

7. FINAL PROTOTYPE

A working prototype system was now capable of being specified in terms of electro-acoustic performance, electrical performance and mechanical size. The system was designed to produce an audible "dont walk" signal capable of being detected and located at a distance of eight metres under normal traffic conditions.

An in-built automatic gain control system then adjusted this level to maintain the specified audible distance under varying conditions of traffic noise. This automatic gain control system was necessarily adjusted with an averaging time constant of 10 minutes to overcome any problems associated with instantaneous traffic noises and runaway feed-back conditions.

The electro-magnetic transducer was designed to be readily mounted in a standard N.S.W. pedestrian push button box with no modification to the external appearance. This transducer

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was then coupled to the electronic control and signal generating network located in a separate box at the top of the traffic control light mounting pole.

8. CONCLUSION

This research programme has set out to critically examine the major features and limitations of local and overseas traffic control aids for blind pedestrians.

We have examined the acoustical, ergonomic, psycho-acoustic and practical problems and limitations involved in adapting the existing N.S.W. pedestrian crossing control systems to provide the facilities which we believe to be necessary. This has been achieved through a critical evaluation of the work of others as well as our own work and what has resulted is a system which we believe will provide a practical and economic solution to the majority of the problems encountered by the blind at pedestrian crossings.

Whilst we anticipate normal teething problems it remains to be seen to what extent the system achieves community acceptance, quite apart from acceptance by the blind pedestrians for whom it was developed. Ironically the normal pedestrian will ultimately benefit more from the introduction of these aids than will the small number of blind pedestrians for whom they were developed. As with any new system, we believe that there will be groups of protagonists and antagonists and we strongly recommend that the attributes not be over-shadowed by sporadic or minor complaints voiced by the antagonists.

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We have discussed this system with blind societies from interstate and overseas, and considering the interest that has already been evoked we believe that the need for this system has fully justified the sponsoring of this project.

In conclusion, we would like to acknowledge the willing and objective assistance of Mr. F. Hulscher from the Department of Motor Transport, N.S.W. and Juliet Bishop of the Guide Dogs for the Blind Association. We are indebted to Audience Studies Incorporated for their practical and unstinting assistance, and last but not least to the blind people who willingly and graciously assisted us.

LOUIS A. CHALLIS AND ASSOCIATES PTY. LTD.

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PRELIMINARY INVESTIGATION INTO CRITERIA FOR TRAFFIC AIDS FOR BLIND PEDESTRIANS

Criteria of acceptability or unacceptability of a traffic aid for blind pedestrians have been researched and well documented to date. A good example of the relative merits and limitations of audible and vibro-tactile devices is shown in the appended table *"Comparison between Two Types of Traffic Control Signals for Blind Pedestrians"* which was produced by the Motor Transport Department of N.S.W.

All the aspects detailed in this table have been considered in this research project. The questionnaire survey conducted by the Motor Transport Department sought statistics on the blind population in N.S.W. to provide a guide for further research work. The basic statistical data from the questionnaire has been documented by the Motor Transport Department and further investigatory work was carried out on the results of one of the questions. This question was to "List those crossings and intersections already provided with traffic lights where you cross regularly".

Each intersection was then categorised by the number of facilities in the immediate vicinity and a graph was then produced showing the intersection facilities versus the number of blind pedestrian users. This graph shows the relative importance of each type of facility in terms of the type of road, available public transport, type of shopping centre, presence of local government offices and facilities, educational facilities, recreational facilities and special facilities for the blind.

COMPARISON BETWEEN TWO TYPES OF TRAFFIC CONTROL SIGNALS FOR BLIND PEDESTRIANS

ASPECT	VIBRATORY SIGNAL*	AUDIBLE SIGNAL**
What is the potential range?	Restricted: within arm's length.	Good: depends on sound intensity.
Can it be clearly recognised above a high level of traffic noise?	Yes.	Yes, provided the intensity/frequency spectrum has been suitably selected.
What are the directional qualities?	Nil.	Poor, but can be optimised by careful choice of frequency spectrum.
Are there adverse environmental effects?	No.	Noise has an inherent nuisance value, especially in light traffic periods.
Is there any benefit for pedestrians with normal sight?	No.	Yes, pedestrians waiting for the crossing signal are readily distracted and may miss the WALK display where it is of short duration.
Does it pose any problems to blind pedestrians unfamiliar with the area (locating problem)?	Unless the device is in universal use, a blind pedestrian may be unaware of its existence.	No.
Can access be obstructed?	Yes, at crowded intersections a pedestrian may have difficulty approaching the device.	No.

ASPECT	VIBRATORY SIGNAL*	AUDIBLE SIGNAL**
Can it be used by pedestrians with hearing defects?	Yes.	Useless to deaf pedestrians, and of restricted use to pedestrians with certain hearing defects.
What is the reliability in service?	Limited owing to mechanical nature of the device.	Good, with careful design and selection of components.
Is the device prone to damage?	Difficult to make vandal-proof.	Can be adequately protected and/or mounted out of reach.
Can the device be aesthetically pleasing?	Difficult, owing to the need to mount an additional "box" low down on the signal pedestal.	Device can be made substantially unobtrusive.
Are there any problems with electrical safety?	Device should be energised from an extra low voltage source.	No, provided the device is mounted out of normal reach.

* A vibratory signal is defined as one detectable by touch (especially fingers).

** An audible signal is defined as a continuous or intermittent sound of fixed tonal composition; it therefore excludes such facilities as pre-recorded spoken messages.

GRAPH SHOWING INTERSECTION FACILITIES VERSUS NUMBER OF BLIND PEDESTRIAN USERS

1. Secondary Roads.
2. Parks, gardens & recreational open land.
3. Post Offices.
4. Main Roads.
5. Public Libraries.
6. Bowling Greens.
7. Hospitals.
8. Railway Stations.
9. Local Government Council Offices.
10. Court Houses.
11. Large Shopping Centres.
12. Swimming Pools.
13. Shopping Complexes under One Roof.
14. Railroad interchanges.
15. Police Stations.
16. Town Halls.
17. Small Shopping Centres.
18. Special Institutions for Blind.
19. Special Employment Facilities for Blind.
20. Ferry Terminals.
21. Retirement & Holiday Village.

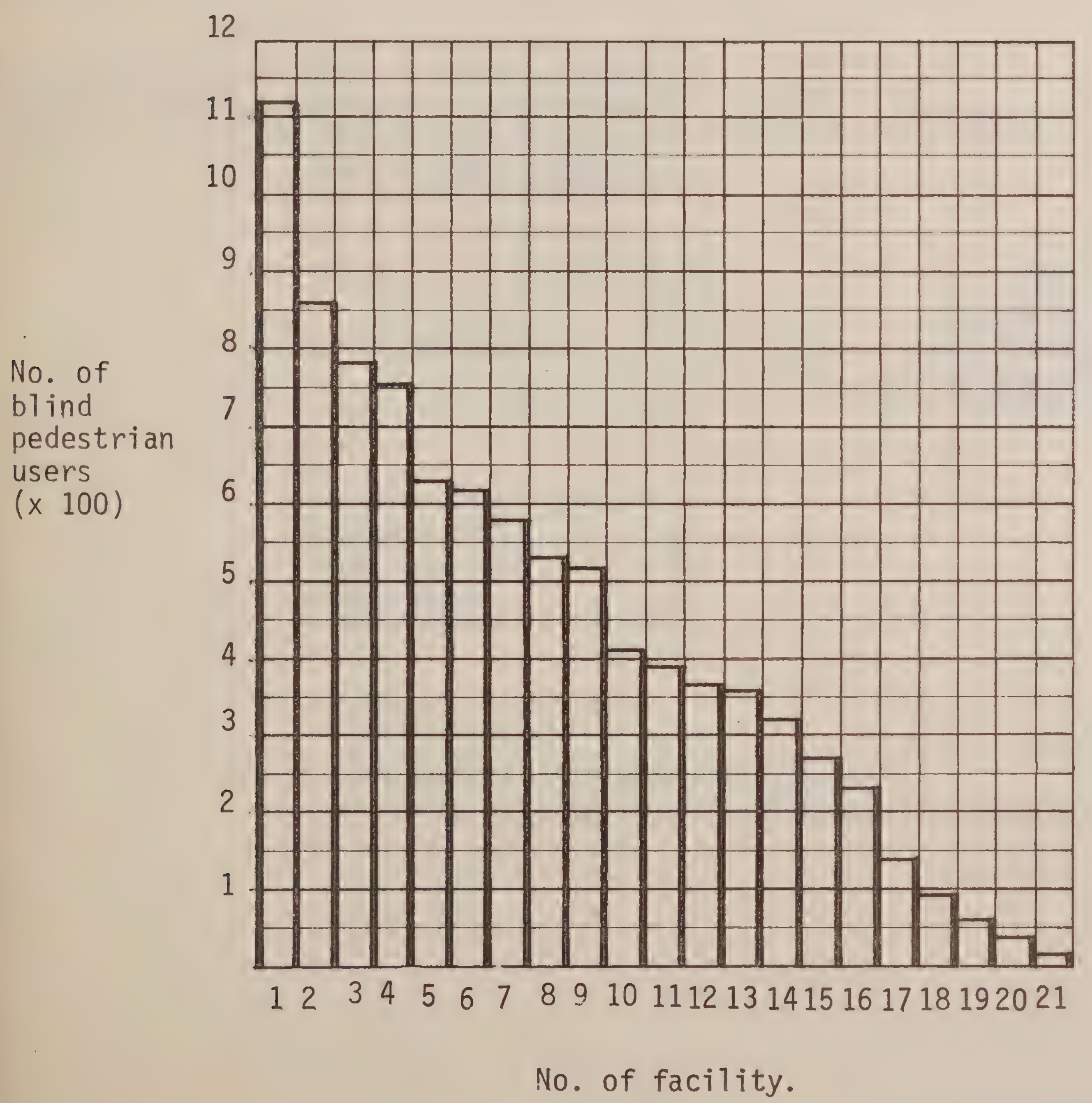
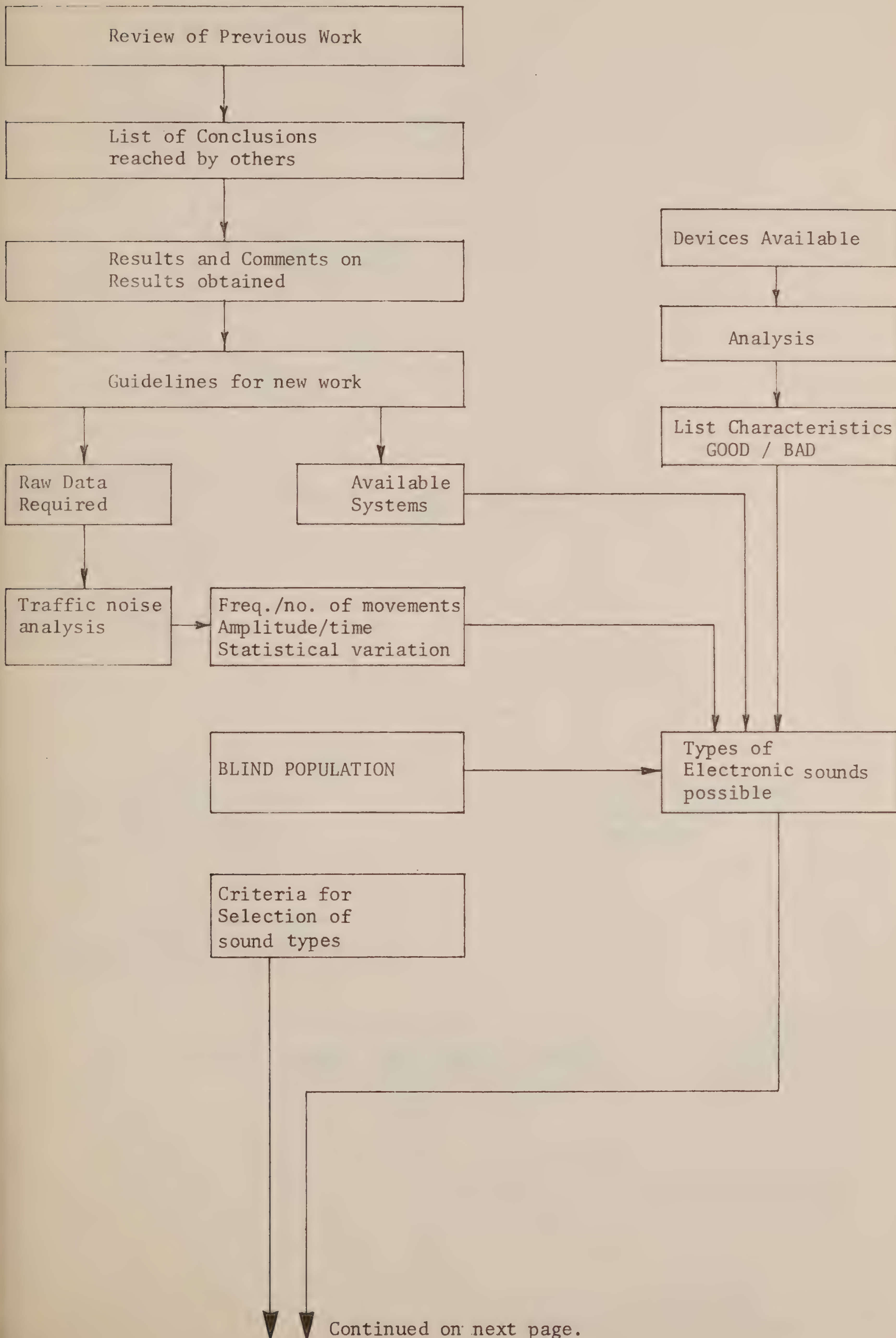


Figure No. 2

FLOW DIAGRAM OF PROJECT



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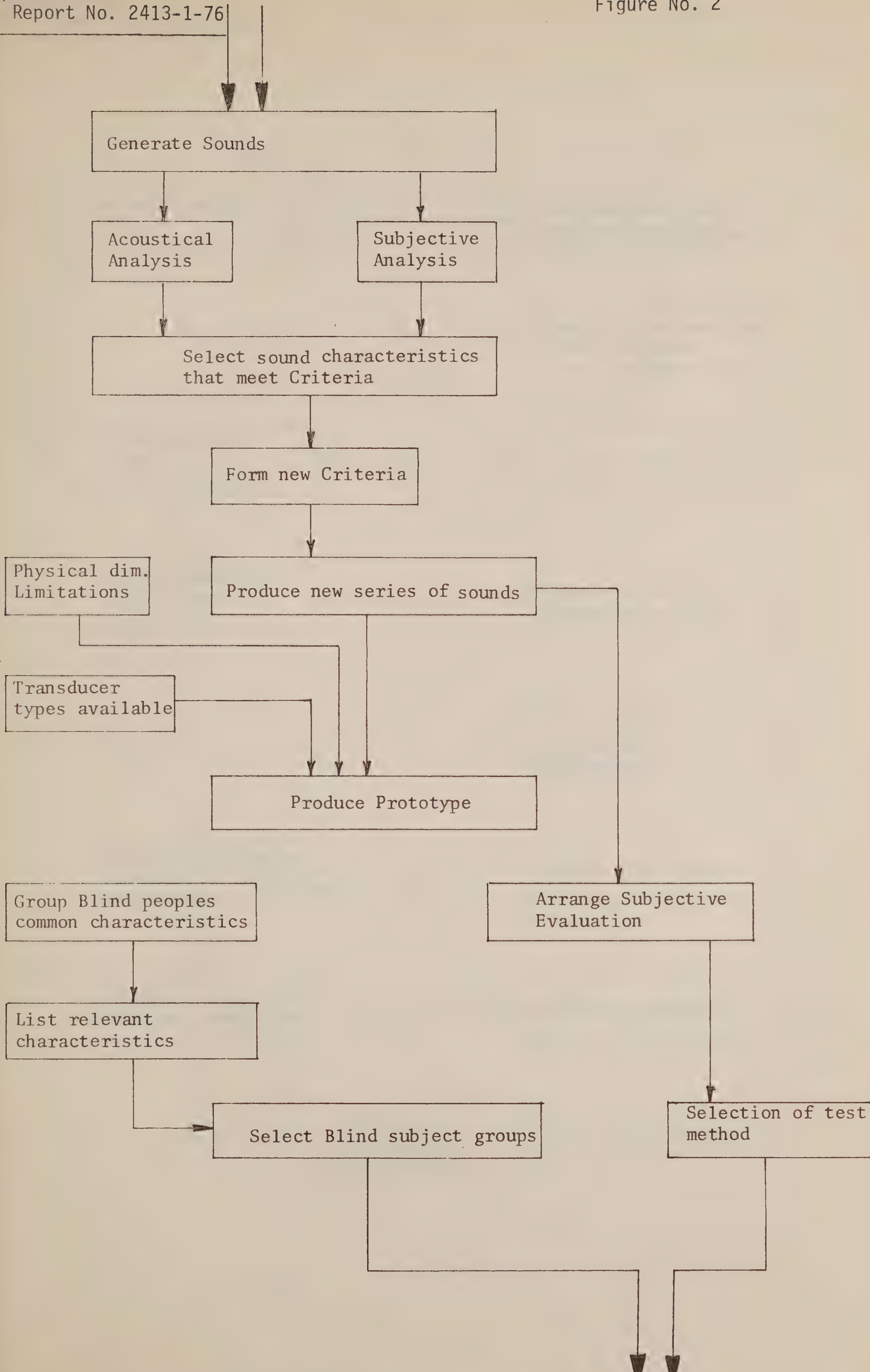
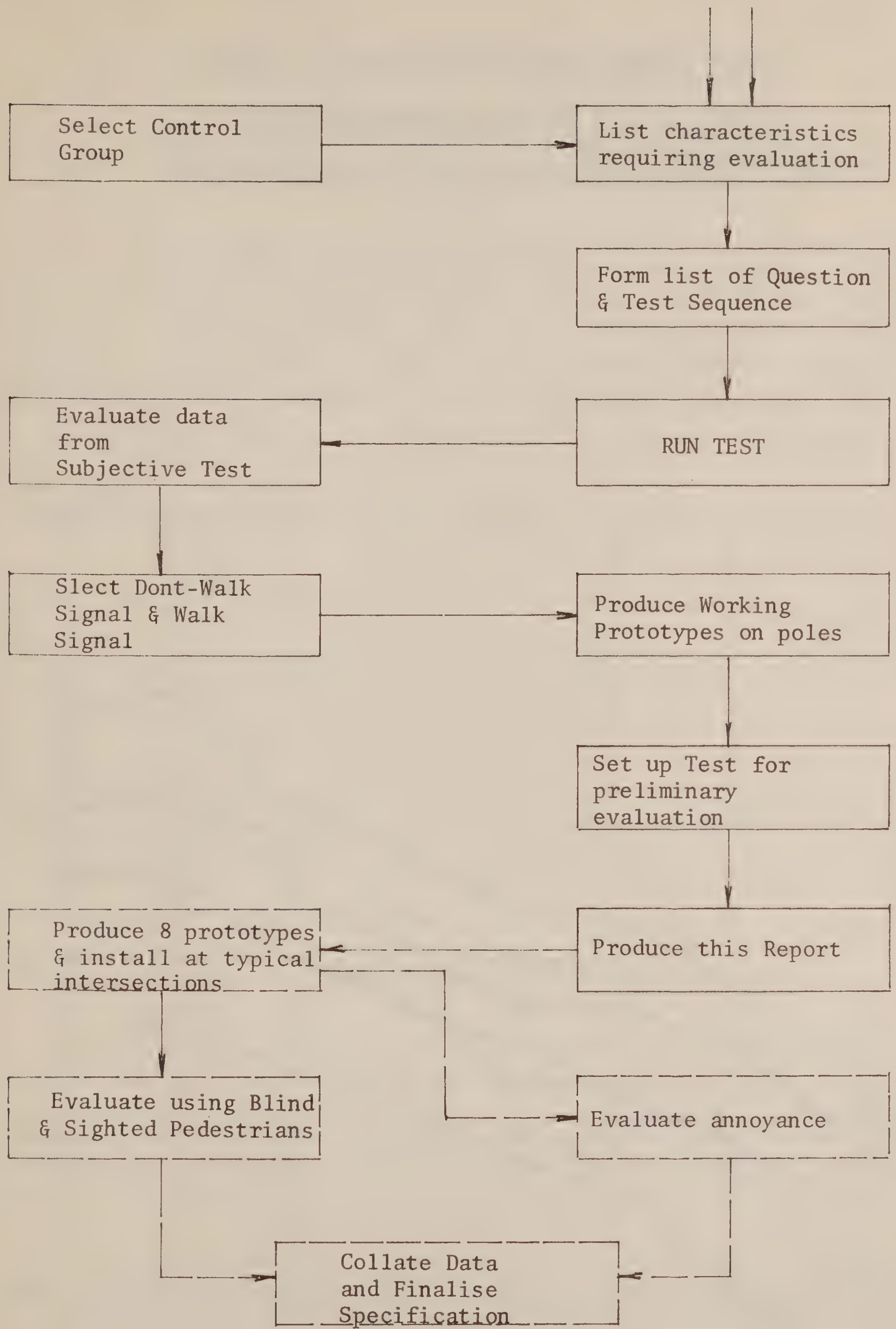


Continued on next page.

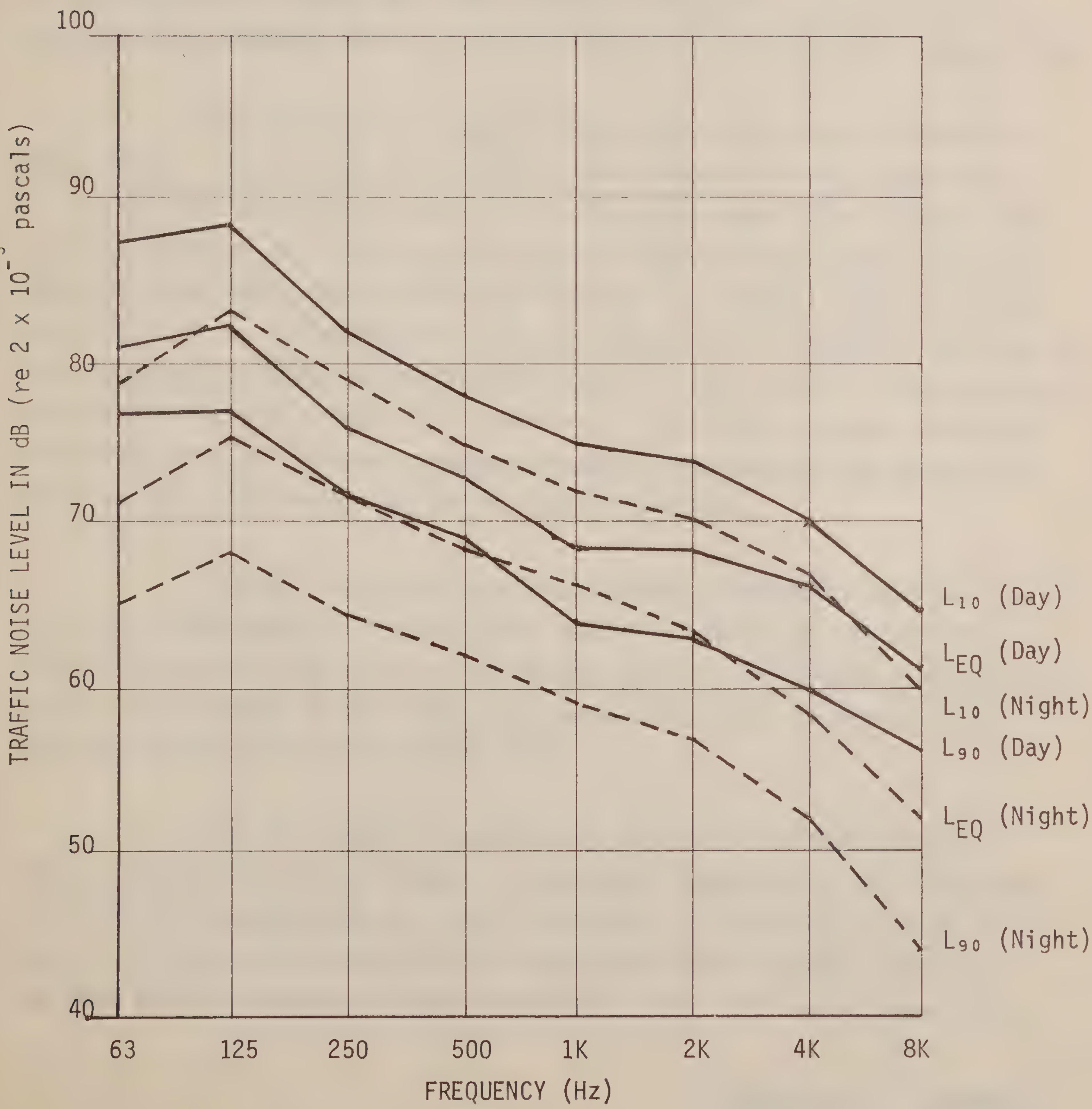
Figure No. 2


Select Control Group
List characteristics requiring evaluation
Form list of Question & Test Sequence
Evaluate data from Subjective Test
RUN TEST
Slect Dont-Walk Signal & Walk Signal
Produce Working Prototypes on poles
Set up Test for preliminary evaluation
Produce 8 prototypes & install at typical intersections
Produce this Report
Evaluate using Blind & Sighted Pedestrians
Evaluate annoyance
Collate Data and Finalise Specification

SPECTRAL DISTRIBUTION OF TYPICAL TRAFFIC NOISE

AT THE THREE EXCEEDANCE LEVELS OF L_{10}, L_{EQ} AND L_{90}

AS MEASURED AT A TRAFFIC LIGHT PEDESTRIAN PUSH BUTTON



INITIAL LABORATORY PSYCHO-ACOUSTICAL INVESTIGATIONS

The psycho-acoustic evaluation of the developmental signals was conducted with the assistance of Audience Studies Incorporated. Together we evaluated the blind people's reaction to the various sounds selected for the detailed investigations. Audience Studies Incorporated specialises in audience reaction to pre-recorded commercials and pilot films. The company has installed a special purpose analogue computer which is capable of systematically logging the individual and combined reactions of an audience, who indicate their response by adjusting a pointer on a control box.

The audience or subjects were seated in a theatre located in Anzac House. The average reverberation time measured in the theatre was one second with no distinct peaks in the frequency range 63Hz to 8kHz. The subjects selected for this test consisted of eleven blind people with good hearing, seven blind people with poor hearing, ten sighted people with good hearing and three sighted people with poor hearing. The audience reaction of each group was printed out individually together with a master chart showing the overall response of the whole audience. Individual subjects from four categories were distributed randomly throughout the back of the theatre to minimise any undesirable bias due to seating position.

Two JBL studio monitor loud speaker enclosures were used as the front stage speakers and the audio amplifier section of the existing television monitors was used to provide the required background traffic noise. The two JBL speakers on the front stage were used solely to reproduce the audible signals selected for these tests.

The test session commenced by initially familiarising the subjects with their control boxes. A one minute sample of a sound was then played to the audience who were then instructed to initially indicate their like or dislike of the sound with no background traffic noise. The sound was then played through the front speakers at three increasing sound levels

...2/

(each of thirty seconds duration) amongst traffic noise and the audience was required to indicate via their control box when they first heard the sound signal.

This method of test was carried out individually on all five "dont walk" signals and all five "walk" signals. The "walk" signals were played initially for fifteen seconds to determine the like or dislike by the audience and then played at three increasing sound levels each of ten seconds duration. At the end of the "dont walk" signals all five signals were played consecutively for a period of fifteen seconds each, with fifteen seconds in between each signal. The audience was required to indicate their relative preference between the signals.

Three of the signals were then presented as a "dont walk" "walk" sequence with the "dont walk" signal being forty-five seconds and the "walk" signal being fifteen seconds. Initially these were presented with no background traffic noise and then for a period of twenty seconds andten seconds respectively at three increasing levels with super-imposed background traffic noise.

The three signals used in this section of the test were the Swedish ticker, the electronic beep sound (1kHz square wave) and the electronic plop sound (500Hz exponentially decaying sine wave). These three signals were then presented in their "dont walk" mode with each signal being presented firstly from the left hand side front stage speaker, then from the right hand side, then again from the left hand side and finally from the right hand side. These signals were presented for a period of ten seconds on each speaker. The sequence of presentation was similar to the previous tests with the signals being initially presented with no background traffic noise and subsequently at three different levels of background traffic noise. The results of these tests are tabulated in the appended graphs together with a block diagram presentation of the test set up arrangements.

...3/

COMMENTS ON AUDIENCE REACTION TESTS

The audience reaction test was based on providing data on the following basic criterion for each audible signal:-

(1) The degree of subjective motivation and acceptance of the signals presented.

- (i) The results provide a pointer towards the likes and dislikes of the blind and sighted population.
- (ii) The reaction of the blind subjects shows whether the signal is aurally acceptable and hence indicates whether it will be used by them.
- (iii) The reaction of the sighted people indicates if any possible environmental problems are likely to arise.
- (iv) The results show average percentage of acceptance by blind subjects and sighted subjects.

(2) The audibility of each signal amongst traffic noise.

- (i) The reaction of the blind population is the relevant factor in determining the type of signal to be selected.
- (ii) The audibility of the signal to the blind subjects with poor hearing is the most critical factor and should weigh most heavily in assessing the results.
- (iii) Results show average percentage of audibility for blind subjects with good versus bad hearing over the three levels presented.

...2/

(3) The degree of discrimination and recognition between the "dont walk" and "walk" signals.

(i) The reaction of blind population is the most relevant factor in assessing this criterion since the signals are their main cue for commencing a crossing.

(ii) The reaction of the sighted population is also relevant. This will show whether they can be suitably prompted by an audible signal.

(iii) The results show average percentage recognition to the "dont walk" and "walk" transition by blind subjects with good versus poor hearing over four tests presented.

(4) The ease of localisation of each signal.

(i) The results from the blind subjects are the most important factor in assessing this criterion since they must be able to recognise the "walk" direction.

(ii) The results show average percentage recognition of left/right transition of signal by the blind subjects with good versus poor hearing over the four tests presented.

The analysis of the chart recorder results highlighted several anomalies such as positive reactions by one or two groups of the audience prior to the signal being presented, negative reactions where only positive reactions were required and non-normalising of pointer position at the end of each test. These results have been interpreted so as to minimise these effects where they are clearly indicated. An example would be the case of a sighted person with poor hearing responding to a low level sound and at the same instant as a blind person with good hearing. The seating arrangements show that the sighted people with poor hearing could readily see the movements of people from other groups in the audience and this can explain some of their reactions.

A detailed analysis of the results of these tests, together with consideration of other practical factors resulted in our selection of the 1kHz tone burst as a "dont walk" signal. From the results this signal was shown to be easily detectable above traffic noise even at low levels, foundto have a reasonable degree of acceptability with blind people and proven to offer extremely good localisation as shown by the last test series. For the "walk" signal the 500Hz exponentially decaying sine wave was selected because of good audibility in the presence of traffic noise, reasonably good directional qualities, a distinctly different sound from the 1kHz tone burst "dont walk" signal and its generation of a high energy pulse suitable for energising vibro-tactile devices. Both these signals selected were easy to produce electronically and hence an initial prototype was constructed based on these signals.

Appendix No. 2
to Report No. 2413-1-76

Figure No. 4

PLAN VIEW - ANZAC THEATRE

SHOWING SUBJECTS SEATING POSITIONS AND EQUIPMENT LOCATION

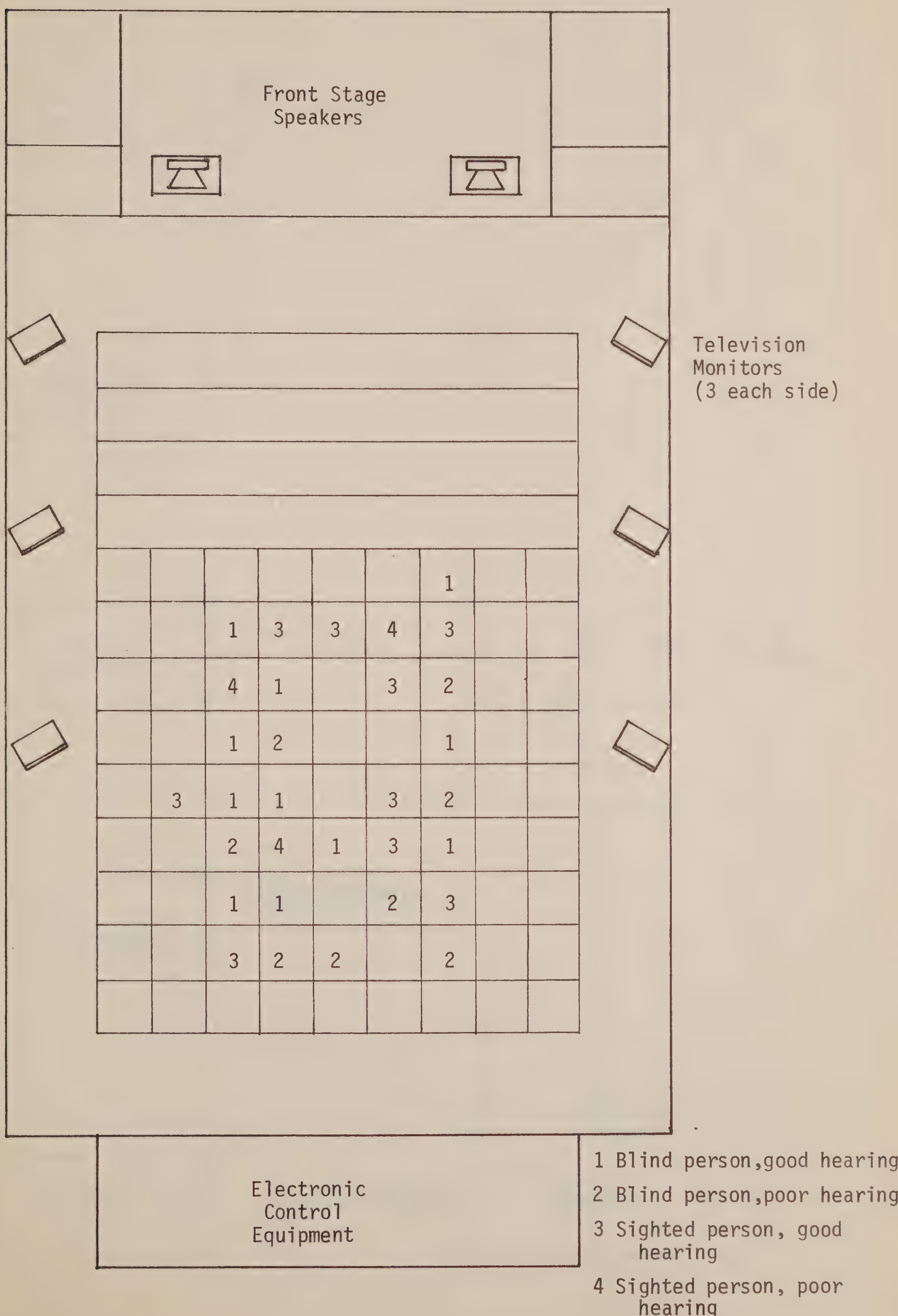
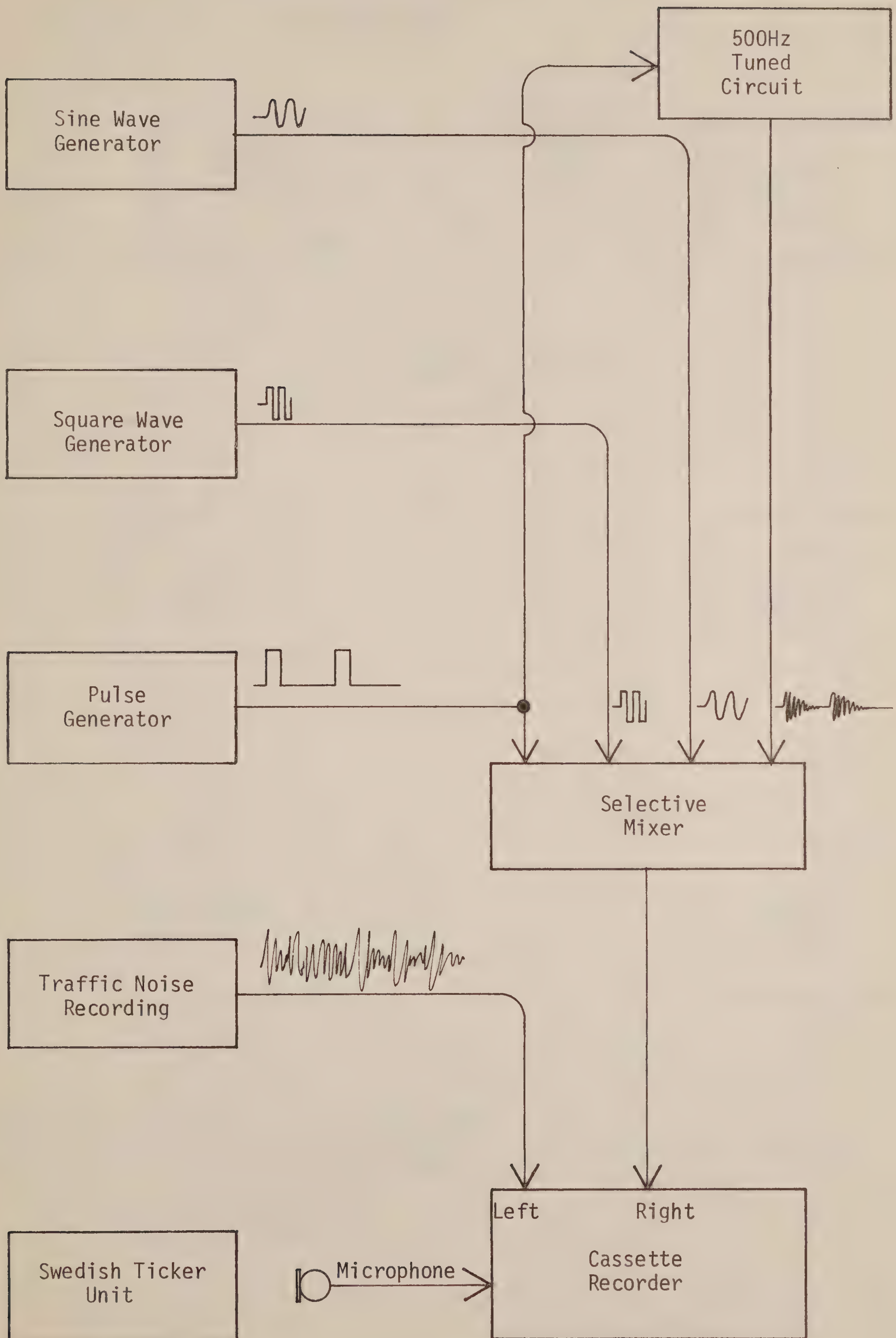


Figure No. 5

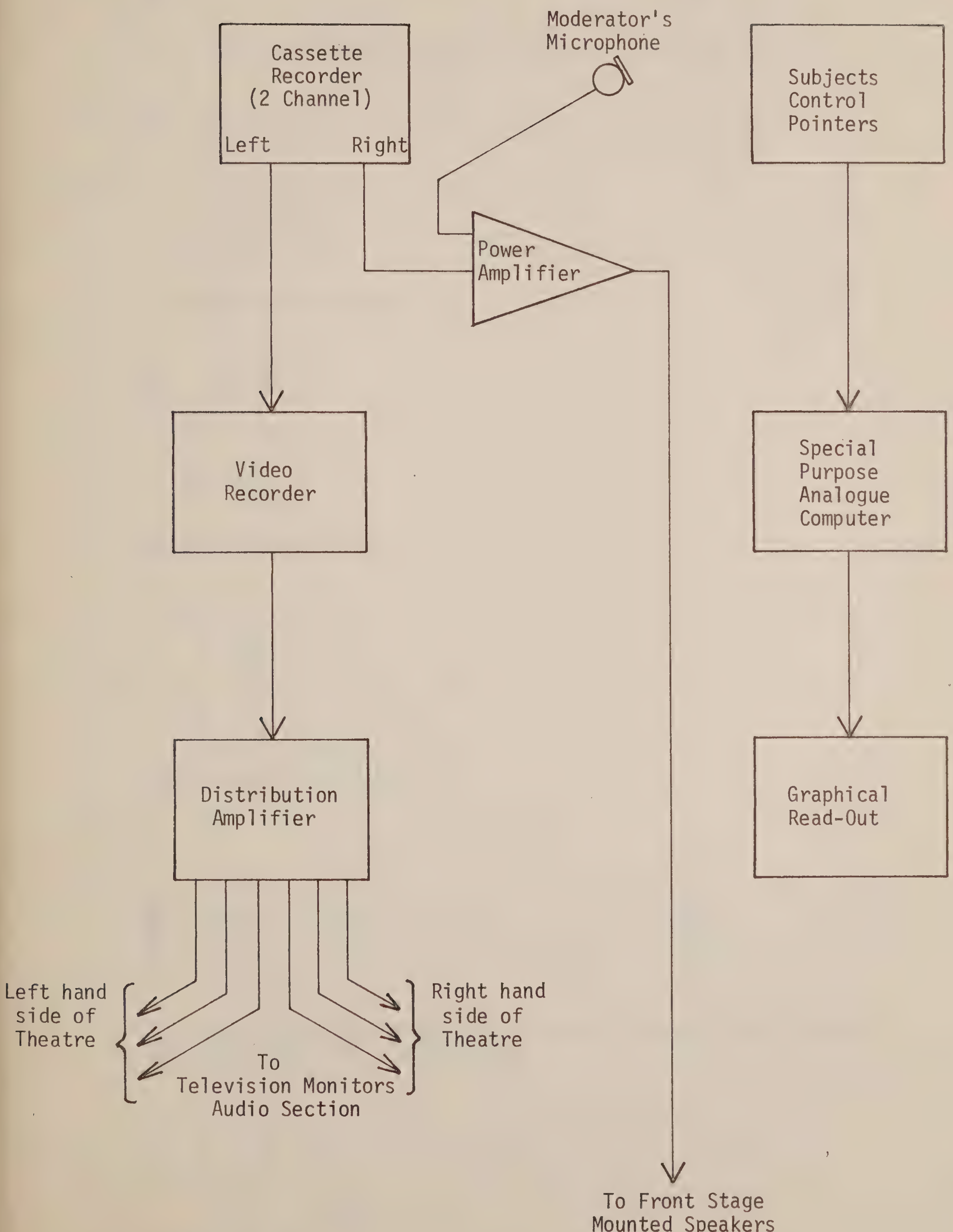
BLOCK DIAGRAM OF

EQUIPMENT SET-UP FOR

RECORDING SOUNDS



BLOCK DIAGRAM OF EQUIPMENT LAYOUT FOR TESTS AT ANZAC HOUSE



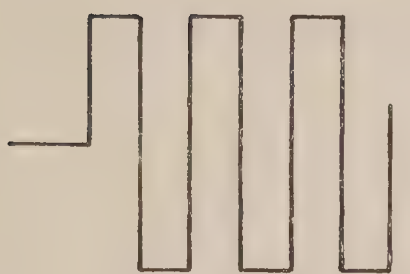
SOUND SIGNALS USED IN INITIAL TEST

Figure No. 7

1.

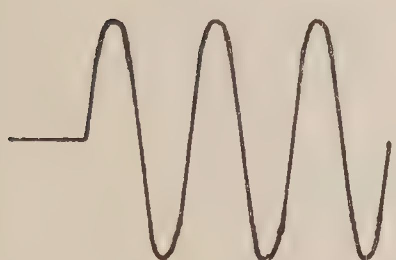
Tone Burst of 25 milliseconds, repetition rate 1 per second.

(a)



1kHz Square Wave Signal

(b)

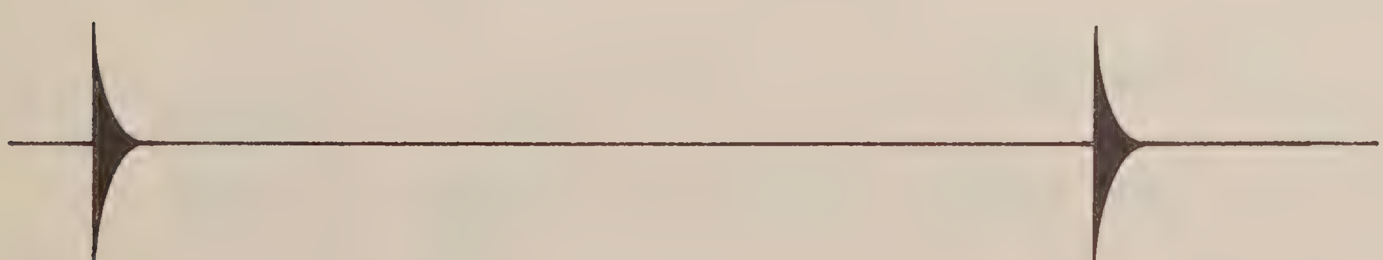


1kHz Sine Wave Signal

(c)

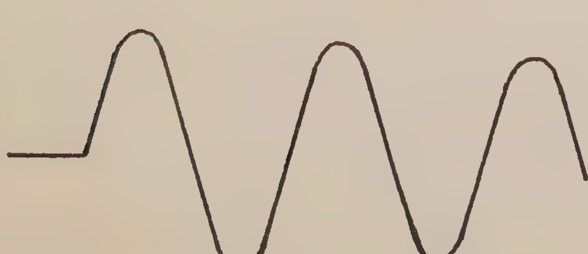
500Hz Square Wave Signal

2.



Exponentially Decaying Burst with 50 milliseconds time constant, and repetition rate 1 per second.

(a)



500Hz Sine Wave

Figure No. 8

LEGEND FOR GRAPHICAL DATA ON AUDIENCE REACTION TESTS

(1) Group Identification

(i) Blind person, good hearing

(ii) Blind person, poor hearing

(iii) Sighted person, good hearing

(iv) Sighted person, poor hearing

(v) Whole audience

(2) Signal Type Identification

(a) Swedish Ticker Unit.

(b) 1kHz Square Wave tone burst.

(c) 1kHz Sine Wave tone burst.

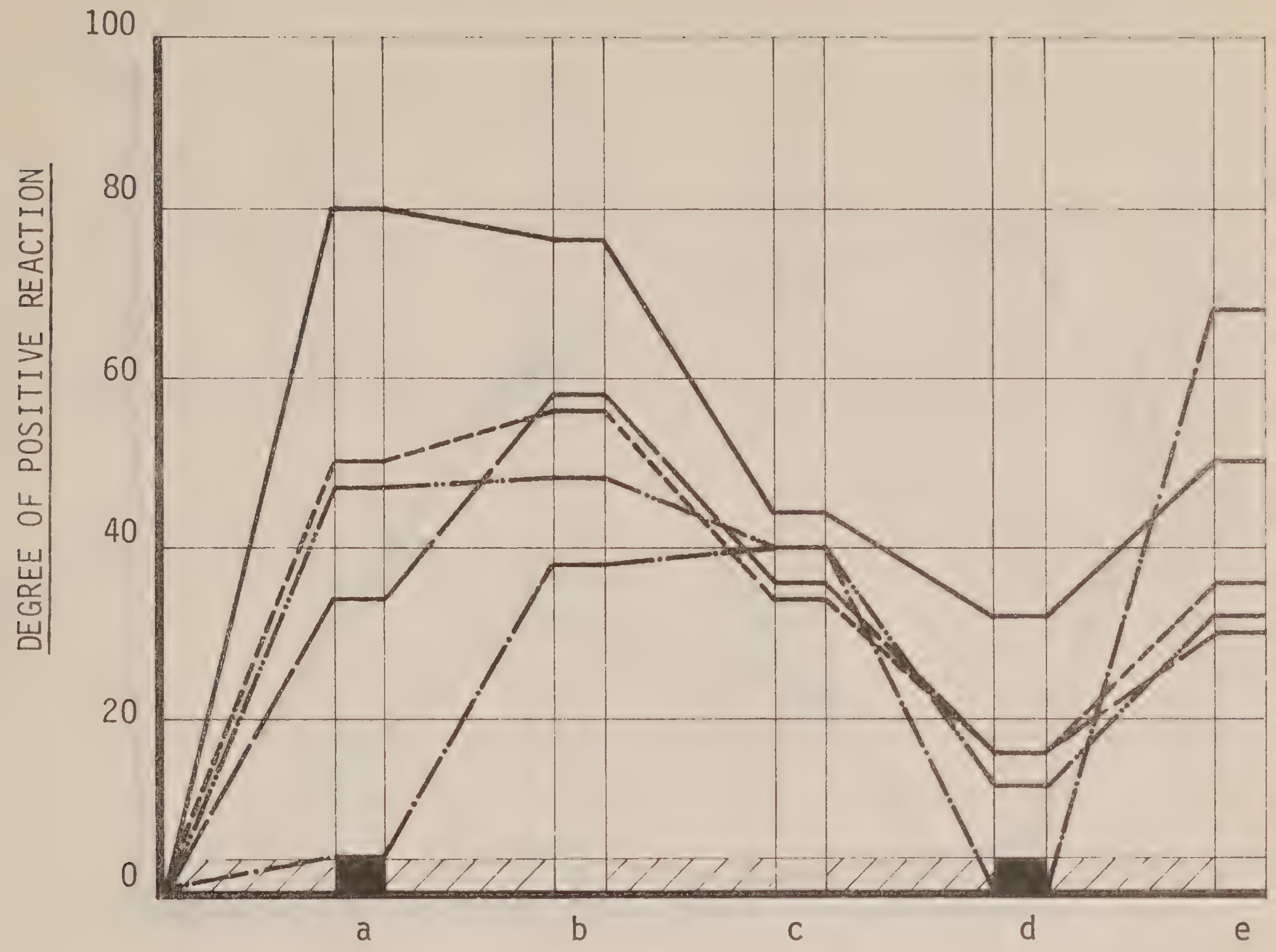
(d) 500Hz Square Wave tone burst.

(e) 500Hz Exponentially Decaying Sine Wave.

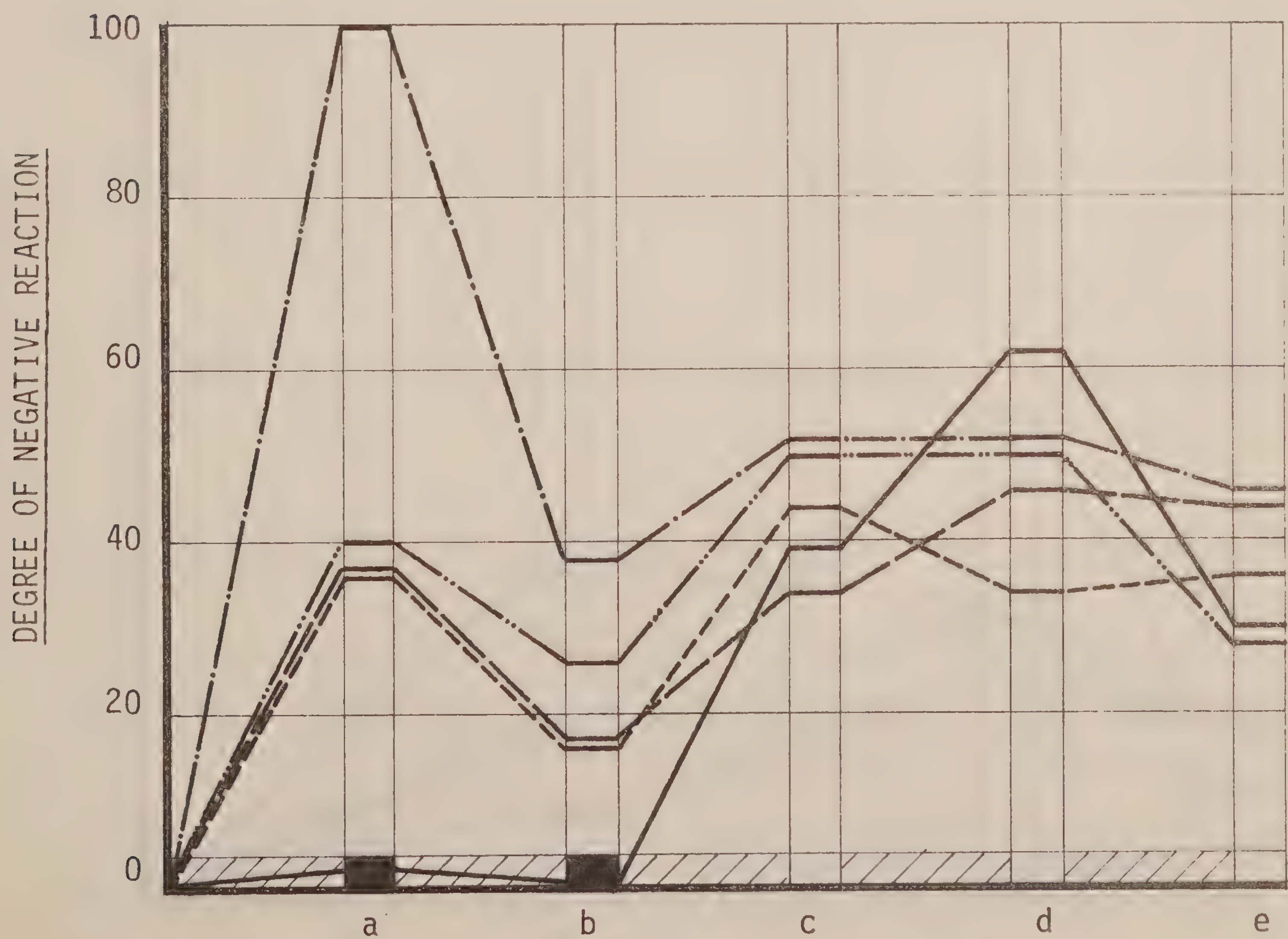
N.B. 1. Columns for signals that were not presented correctly has been left blank.

2. Audience response of less than 2% has been shown as black out square.

Figure No. 9

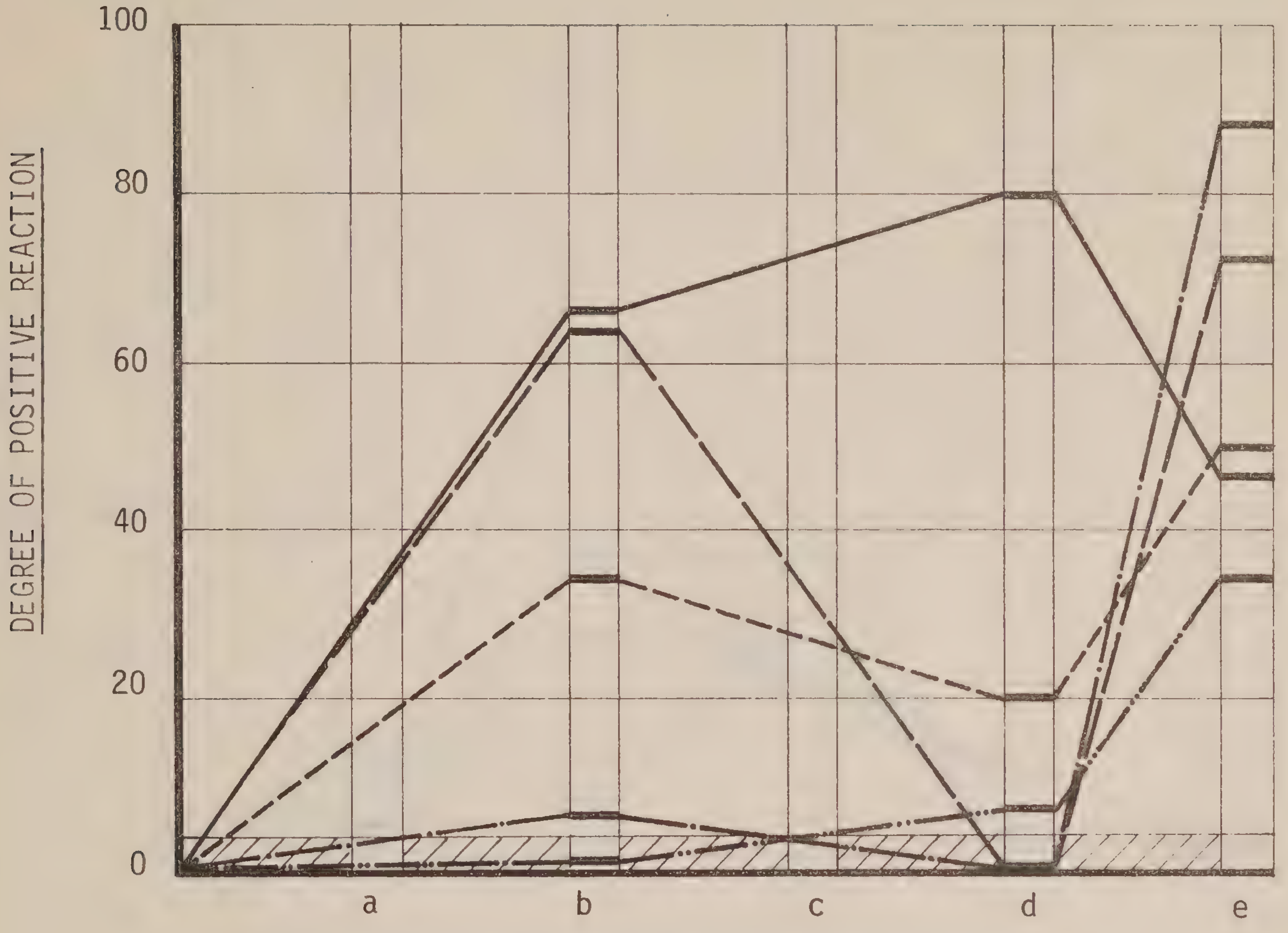


FAVOURABLE AUDIENCE REACTION TO "DONT WALK" SIGNALS

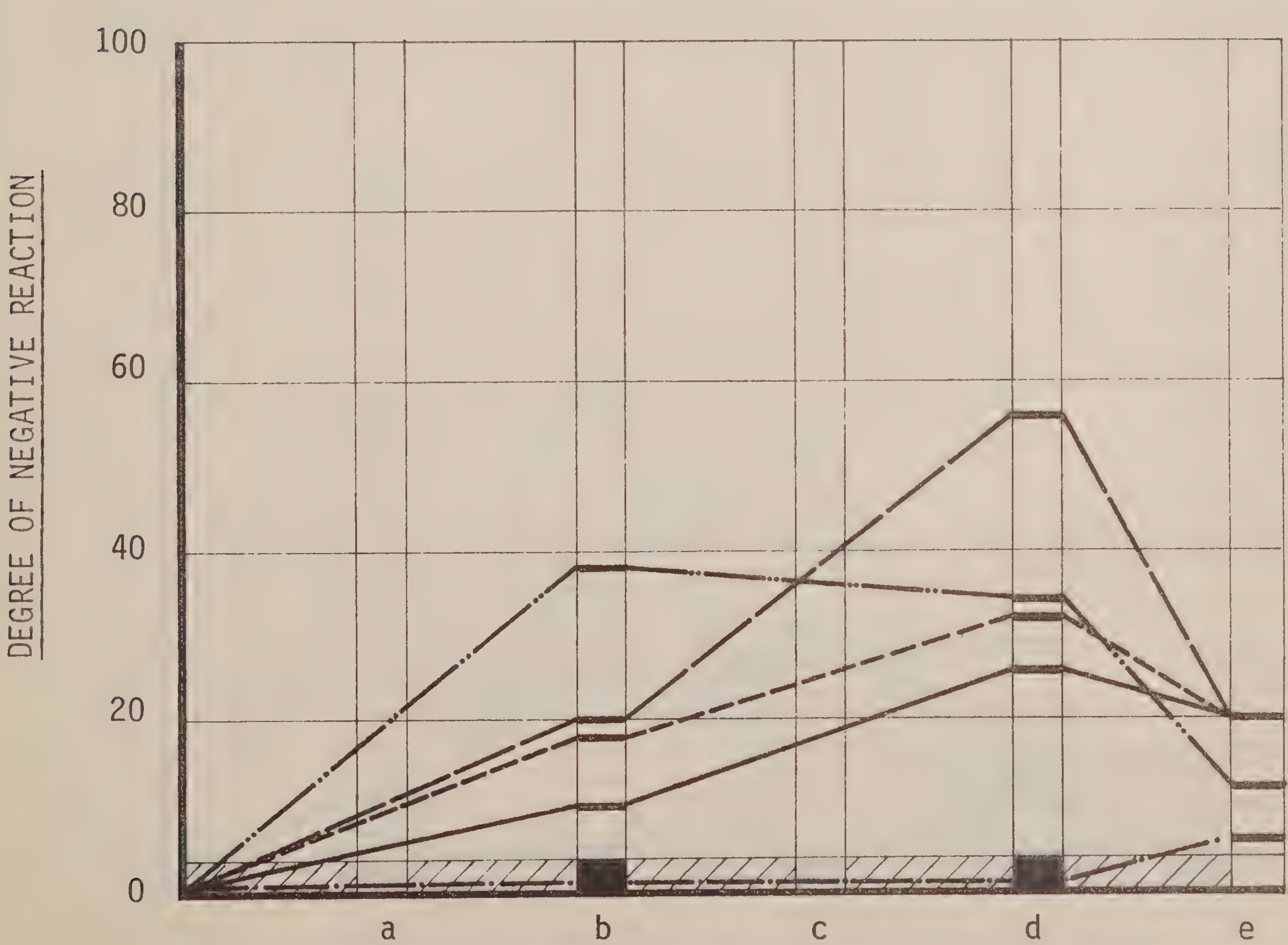


UNFAVOURABLE AUDIENCE REACTION TO "DONT WALK" SIGNALS

Figure No. 10

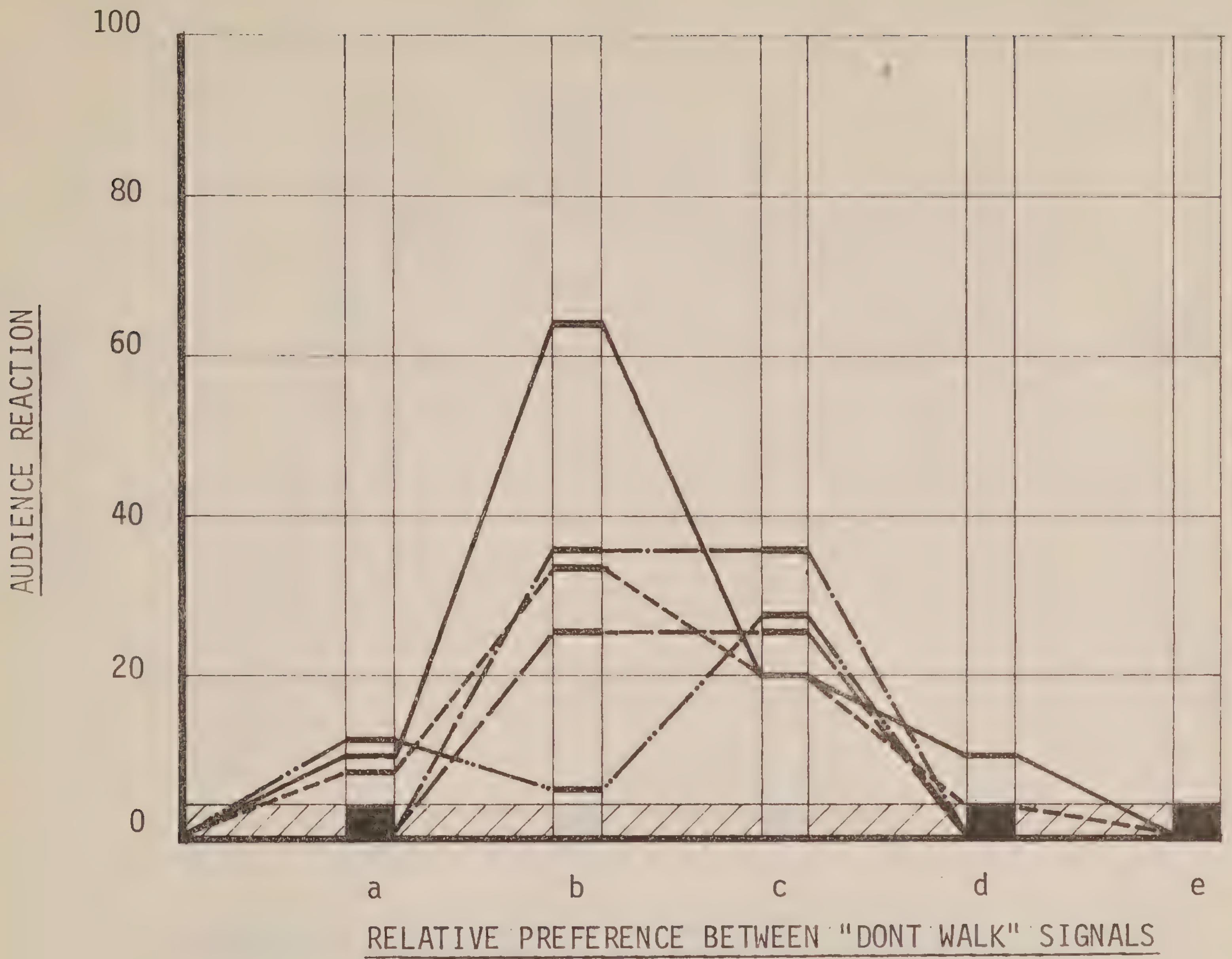


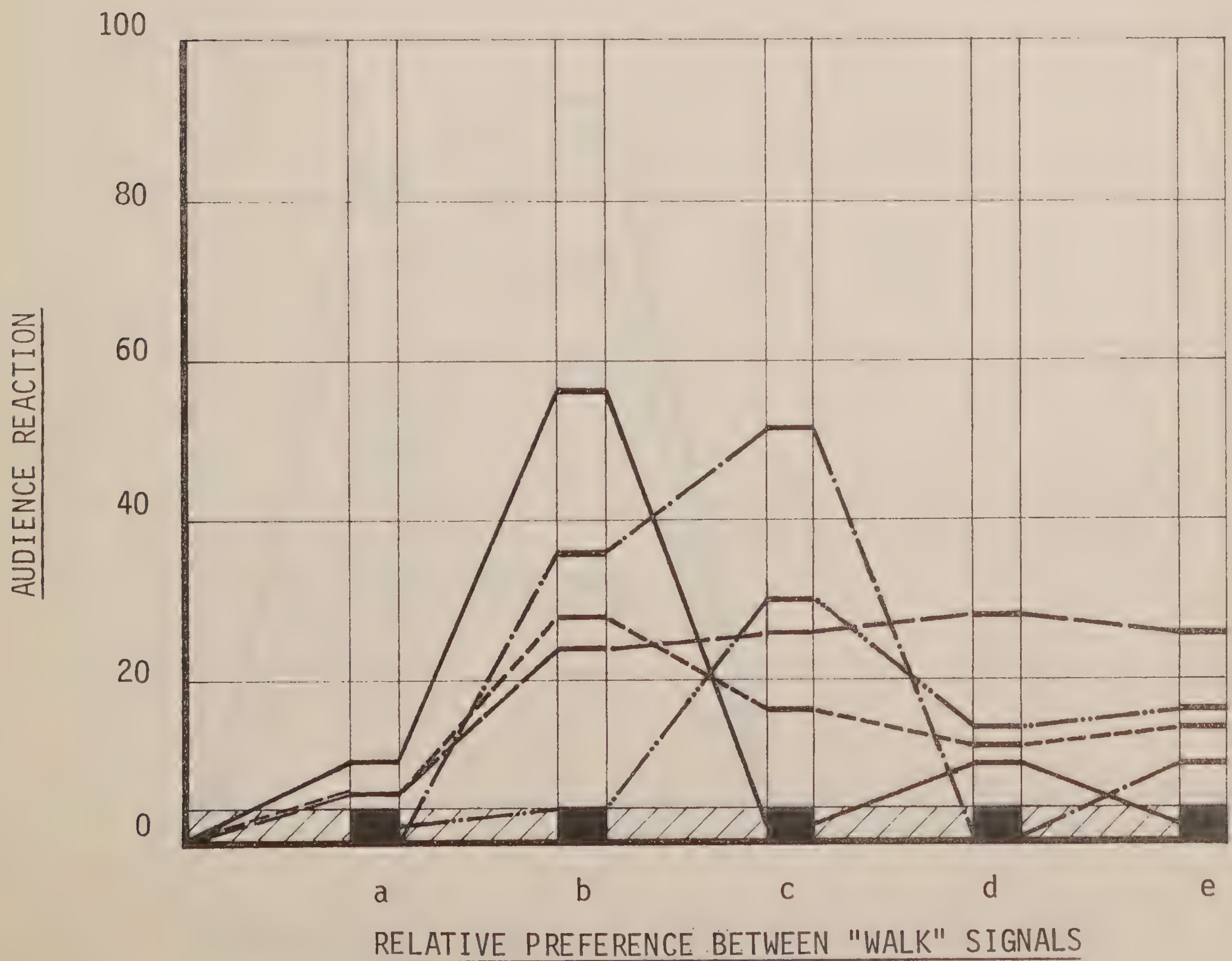
FAVOURABLE AUDIENCE REACTION TO "WALK" SIGNALS

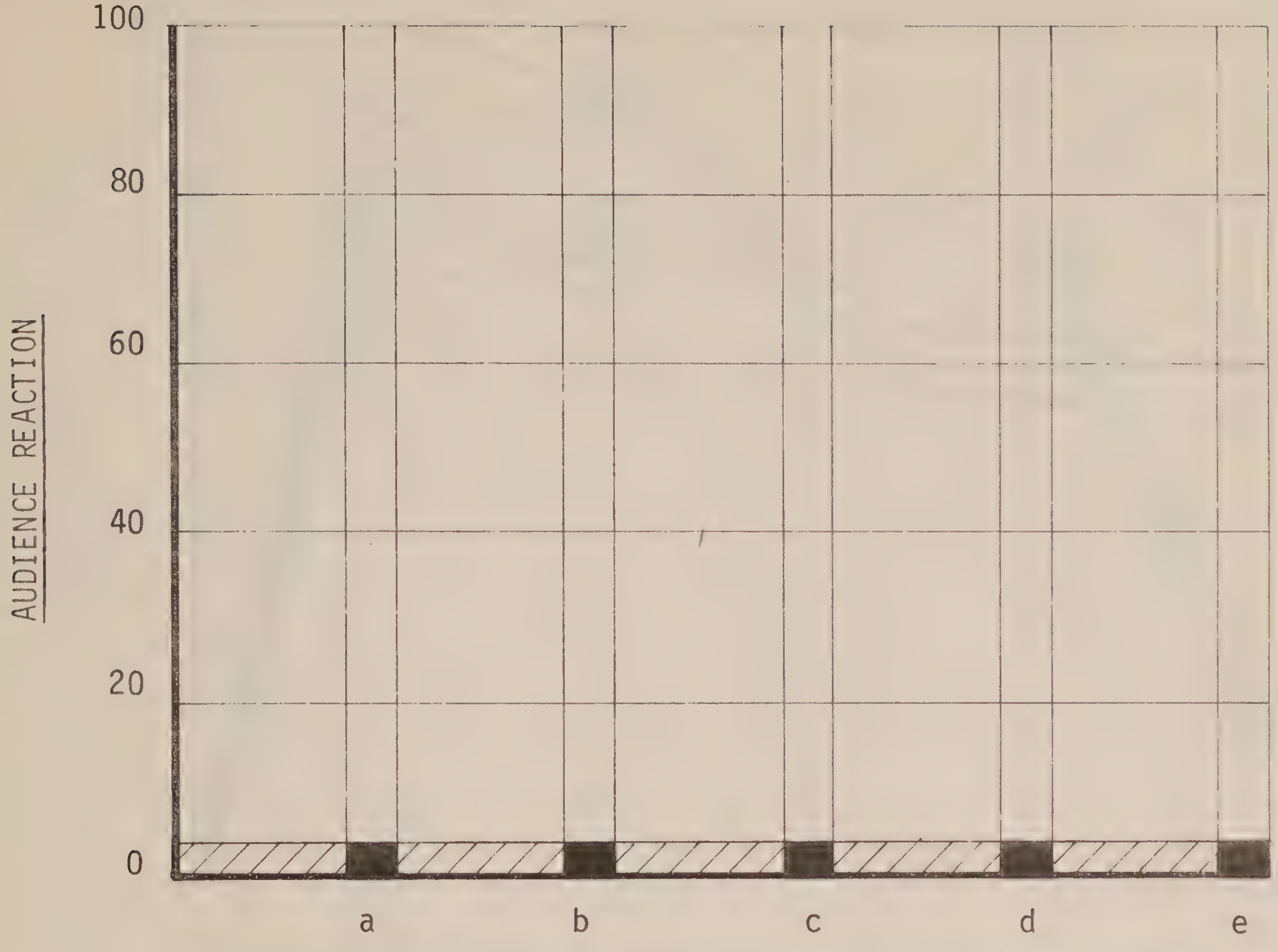


UNFAVOURABLE AUDIENCE REACTION TO "WALK" SIGNALS

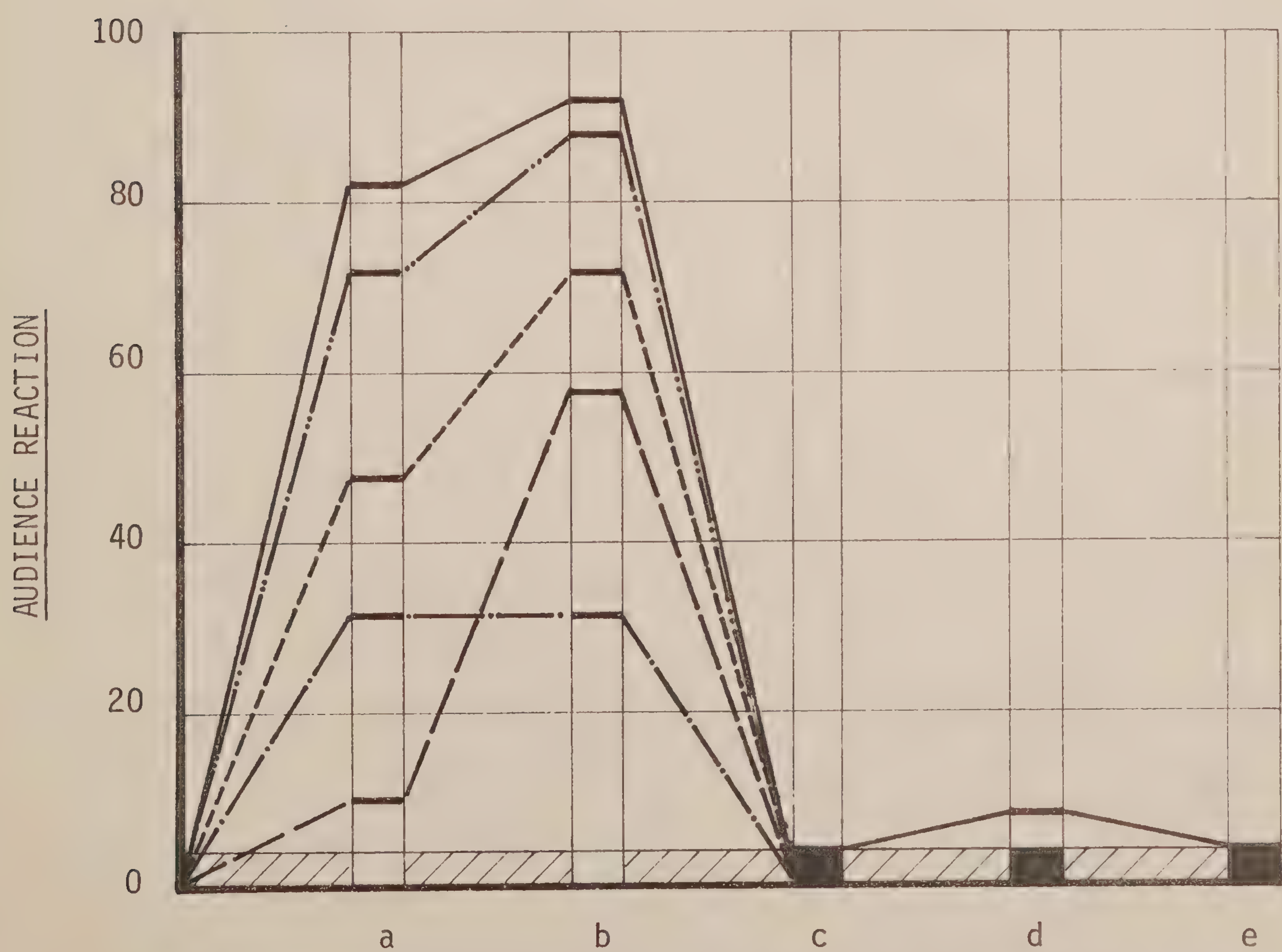
Figure No. 11


100
80
60
40
20
0
AUDIENCE REACTION
a
b
c
d
e
RELATIVE PREFERENCE BETWEEN "DONT WALK" SIGNALS

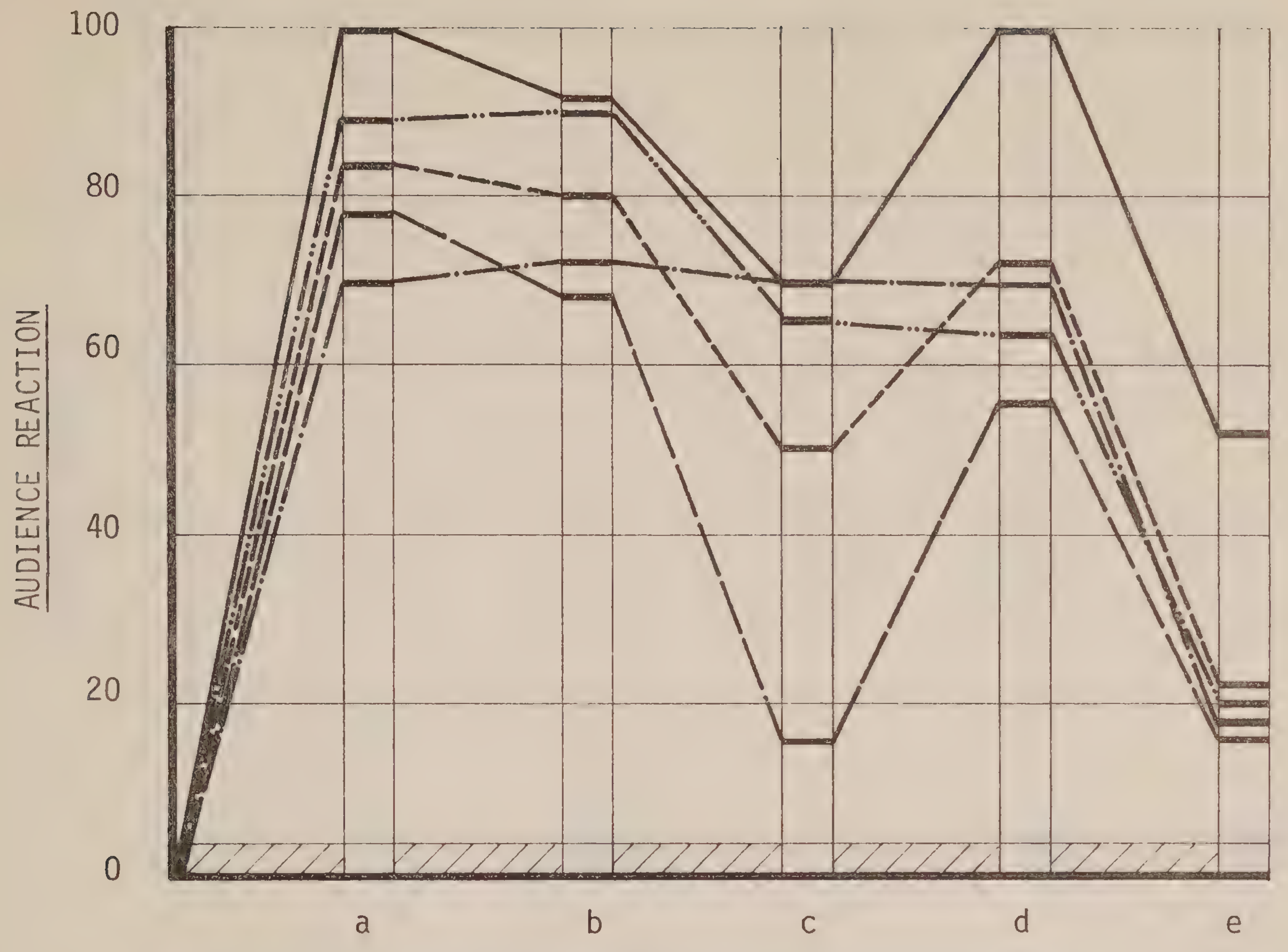

100
80
60
40
20
0
AUDIENCE REACTION
a
b
c
d
e
RELATIVE PREFERENCE BETWEEN "WALK" SIGNALS



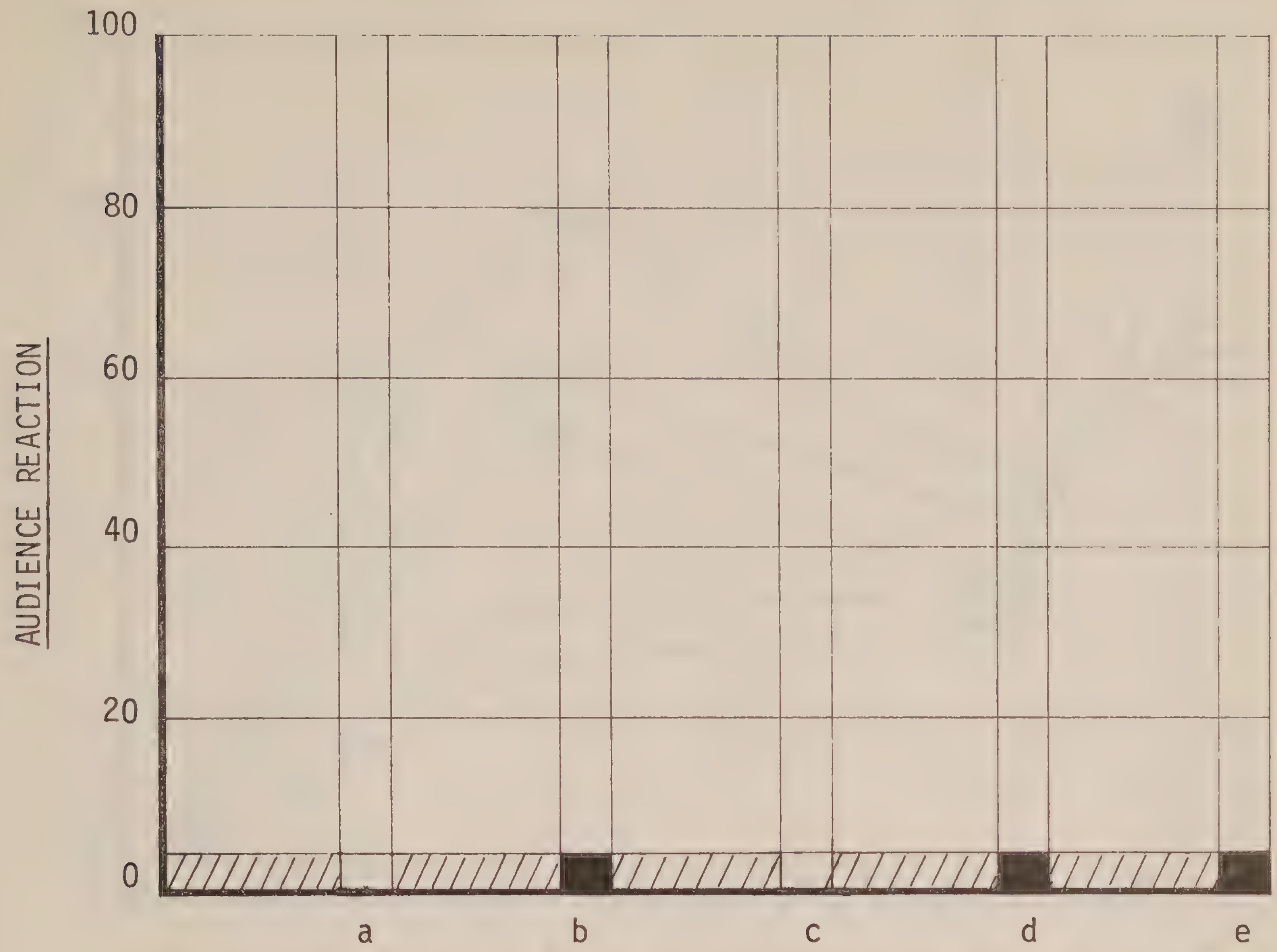
AUDIBILITY OF "DONT WALK" SIGNALS AT -10dB LEVEL re 0dB FOR TRAFFIC NOISE



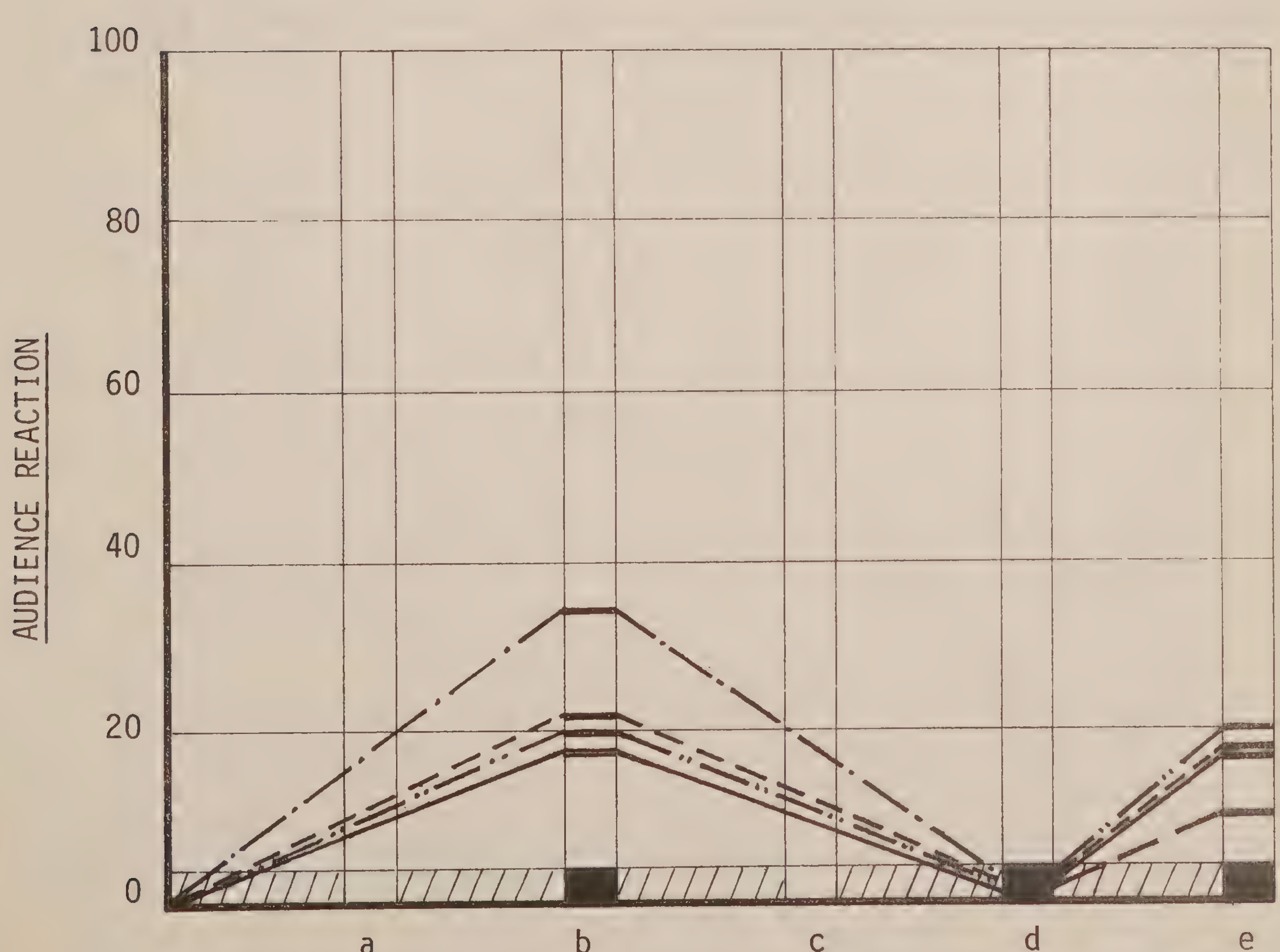
AUDIBILITY OF "DONT WALK" SIGNALS AT 0dB LEVEL re 0dB FOR TRAFFIC NOISE



AUDIBILITY OF "DONT WALK" SIGNALS AT +10dB LEVEL re 0dB
FOR TRAFFIC NOISE

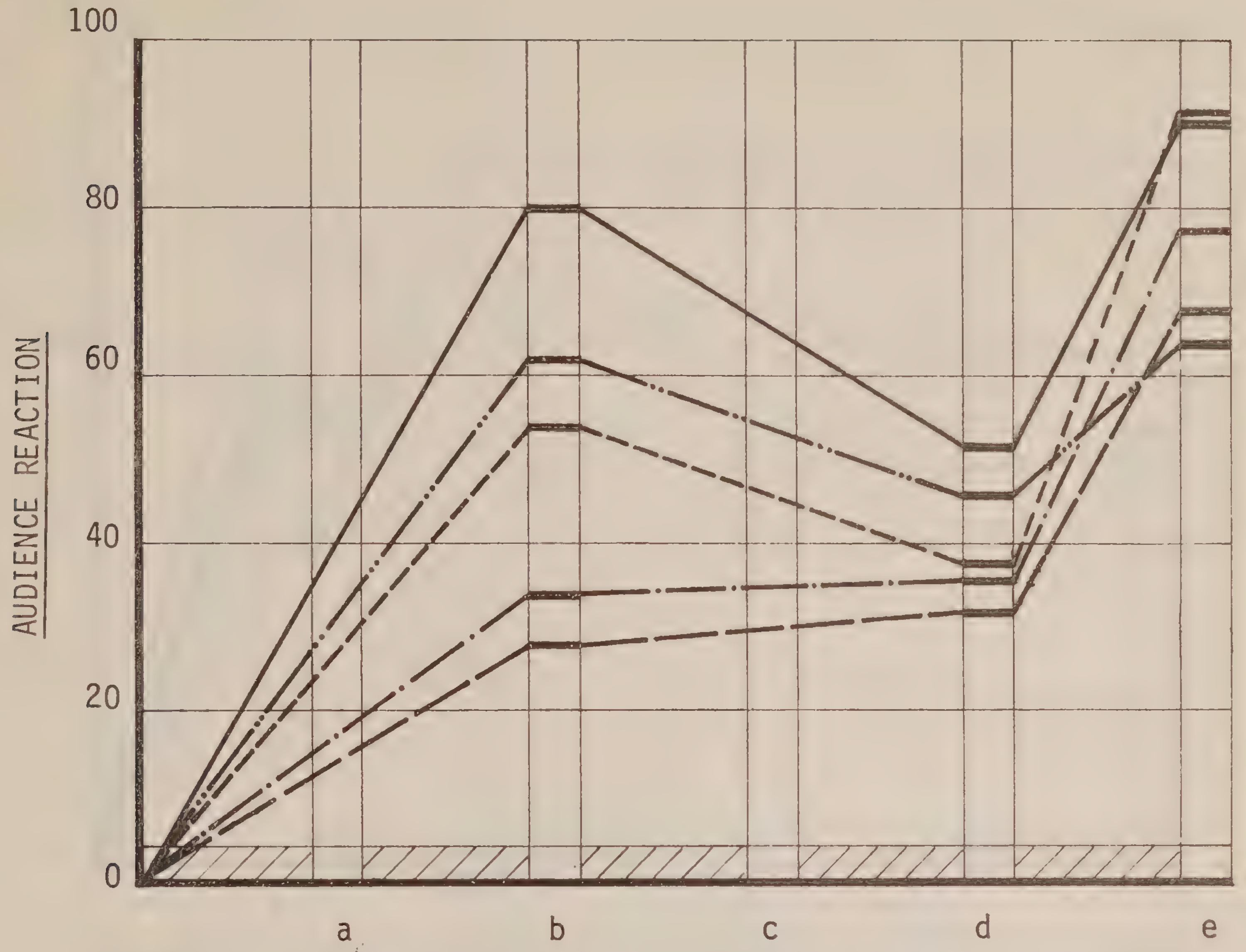


AUDIBILITY OF "WALK" SIGNALS AT -10dB LEVEL re 0dB FOR TRAFFIC NOISE



AUDIBILITY OF "WALK" SIGNALS AT 0dB LEVEL re 0dB FOR TRAFFIC NOISE

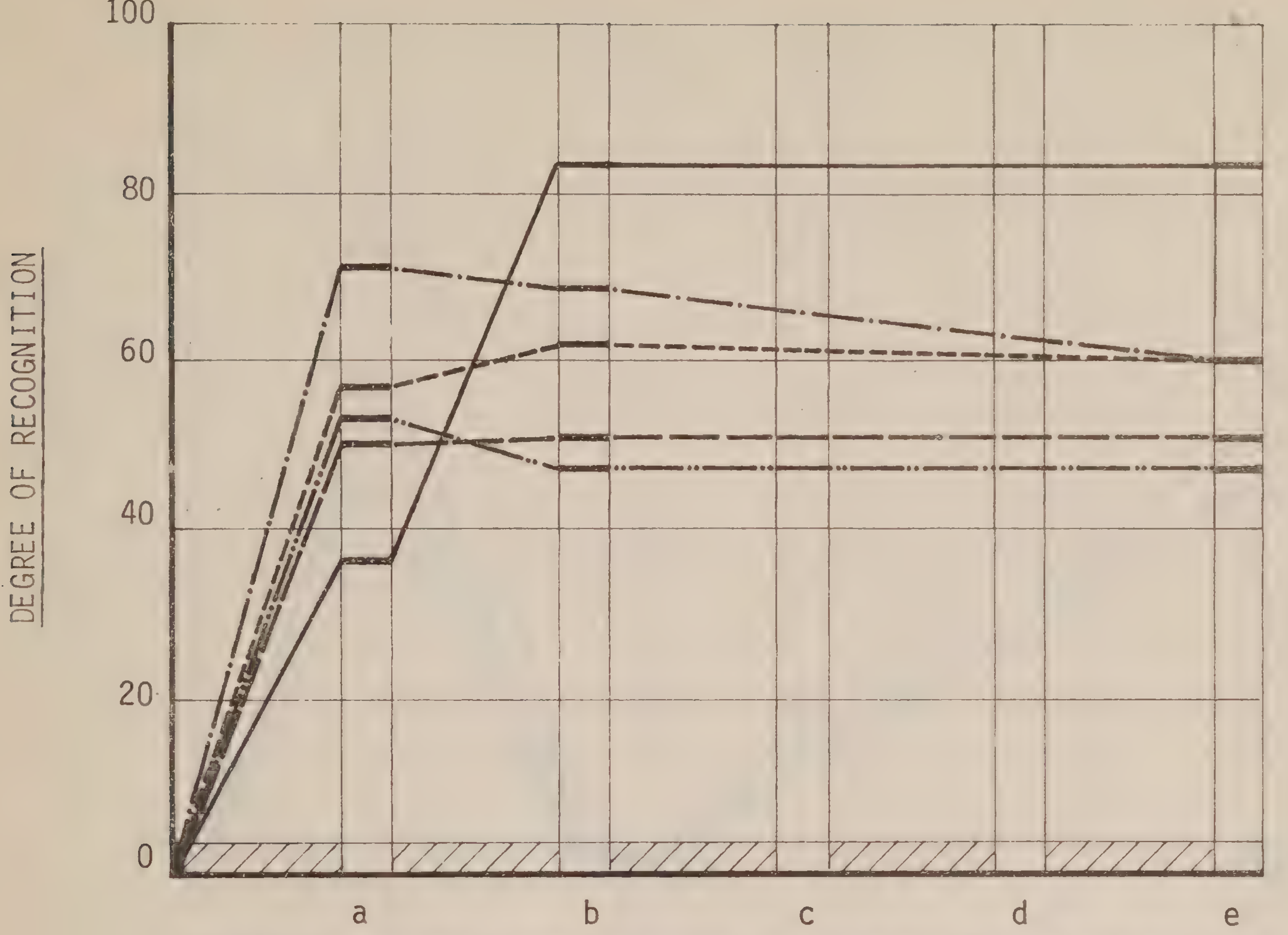
Figure No. 15



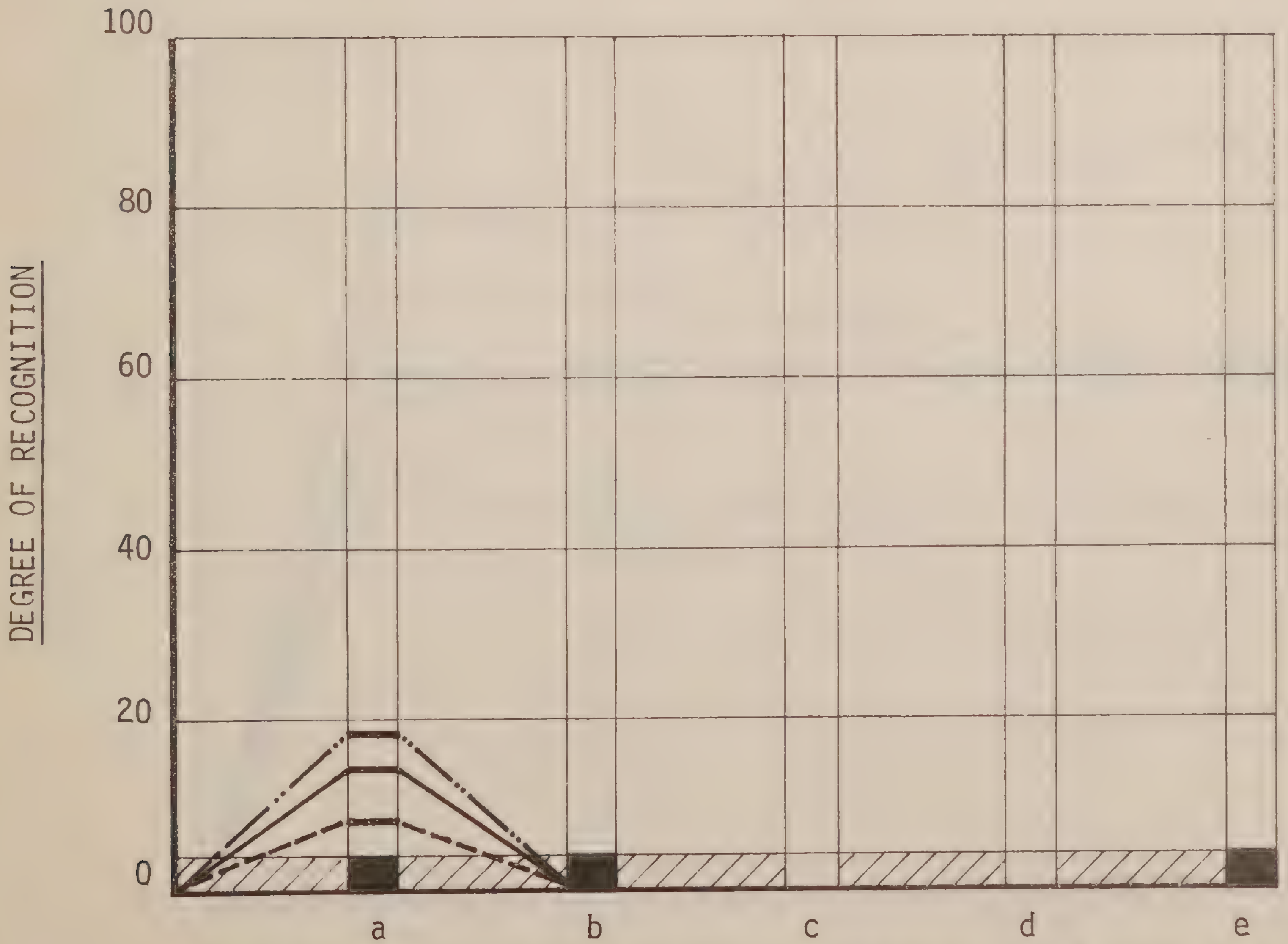
AUDIBILITY OF "WALK" SIGNALS AT +10dB LEVEL re 0dB FOR
TRAFFIC NOISE

(N.B. "Walk" signal types 'a' and 'c' were faulty for this test)

Figure No. 16

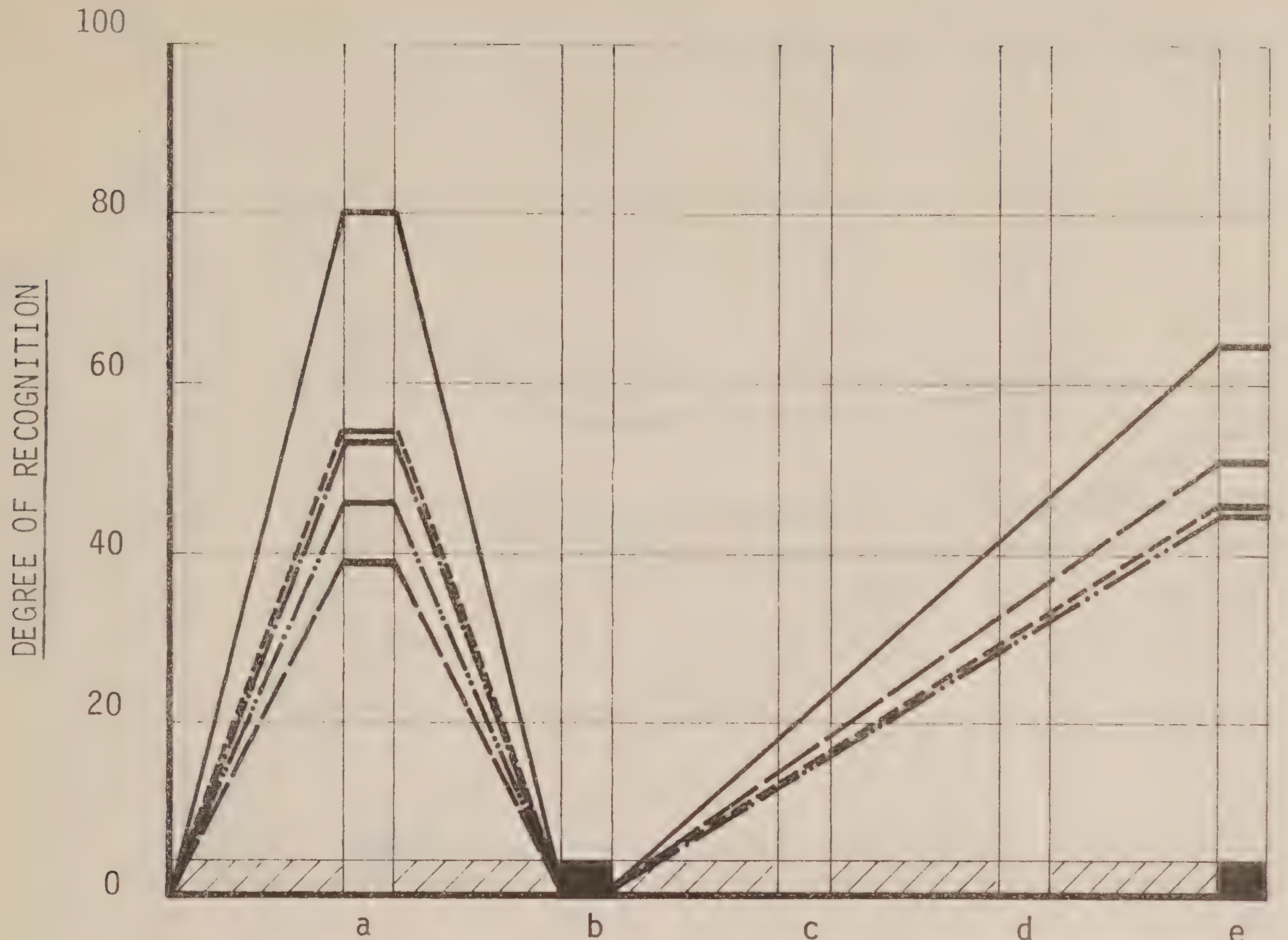


RELATIVE RECOGNITION OF AUDIBLE DIFFERENCE BETWEEN "DONT WALK" AND "WALK" SIGNALS (NO TRAFFIC NOISE)

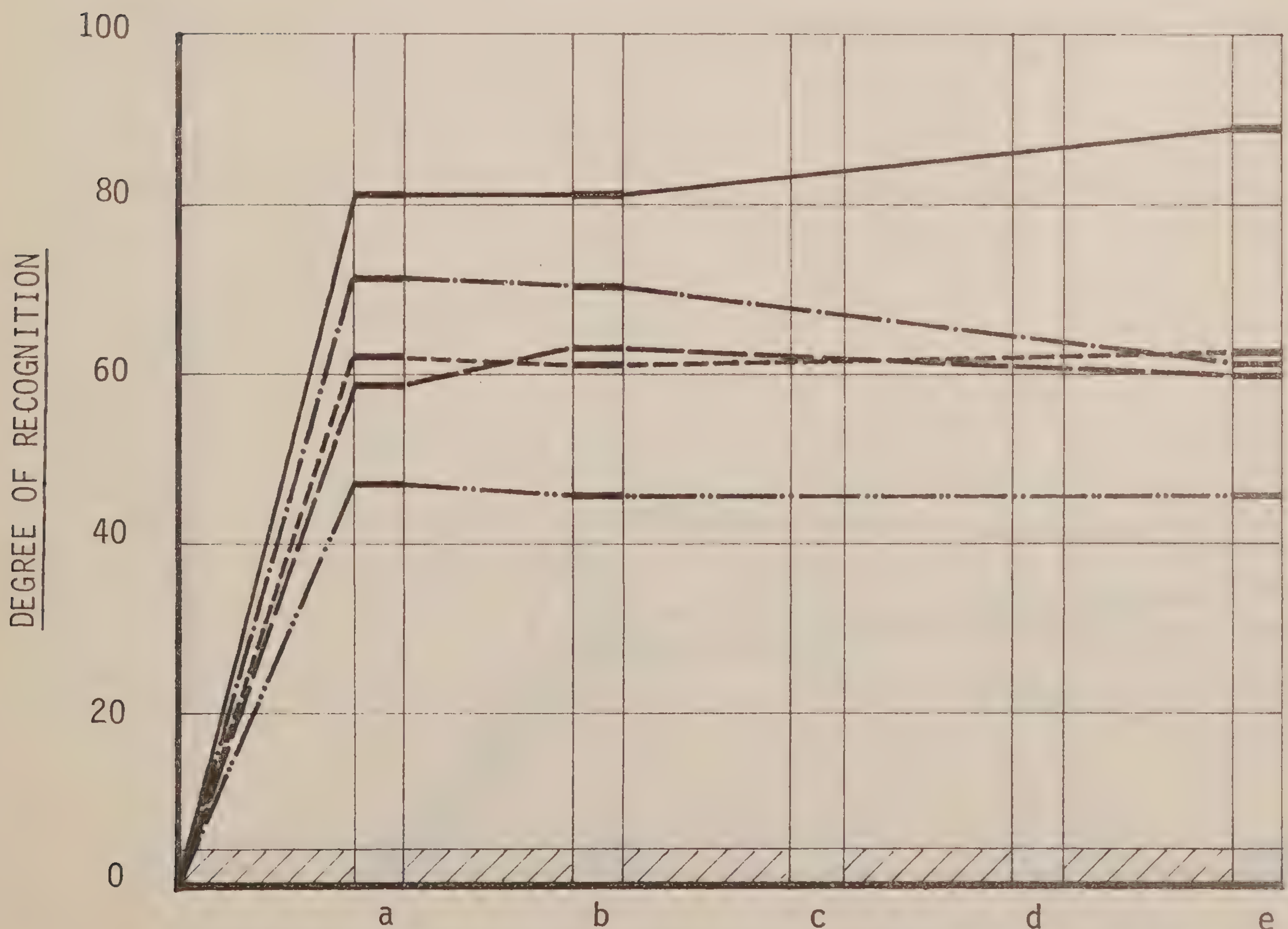


RELATIVE RECOGNITION OF AUDIBLE DIFFERENCE BETWEEN "DONT WALK" AND "WALK" SIGNALS AT -10dB LEVEL re 0dB LEVEL WITH BACKGROUND TRAFFIC NOISE

Figure No. 17

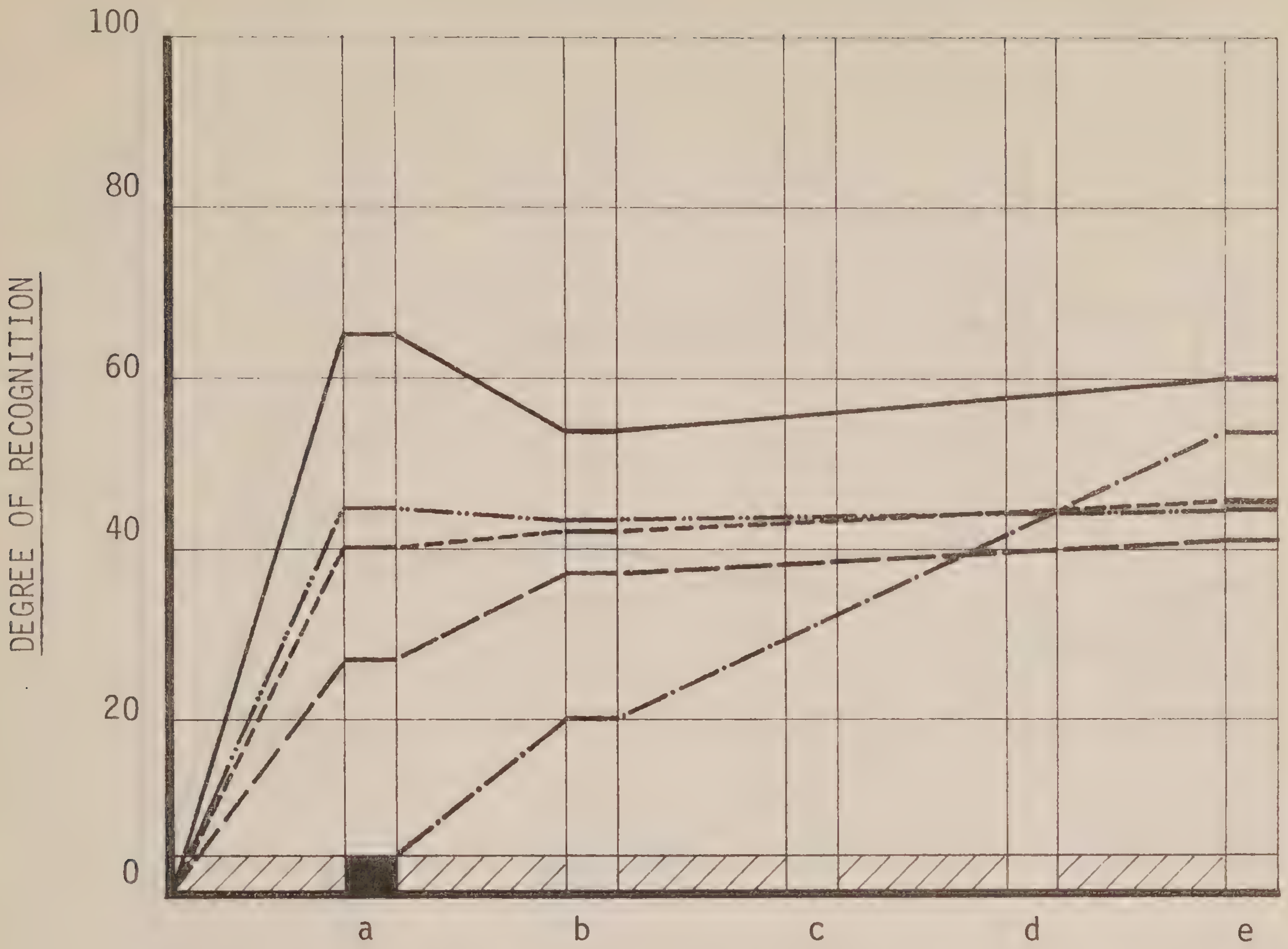


RELATIVE RECOGNITION OF AUDIBLE DIFFERENCE BETWEEN "DONT WALK" AND
AND "WALK" SIGNALS AT 0dB LEVEL re 0dB LEVEL BACKGROUND TRAFFIC NOISE

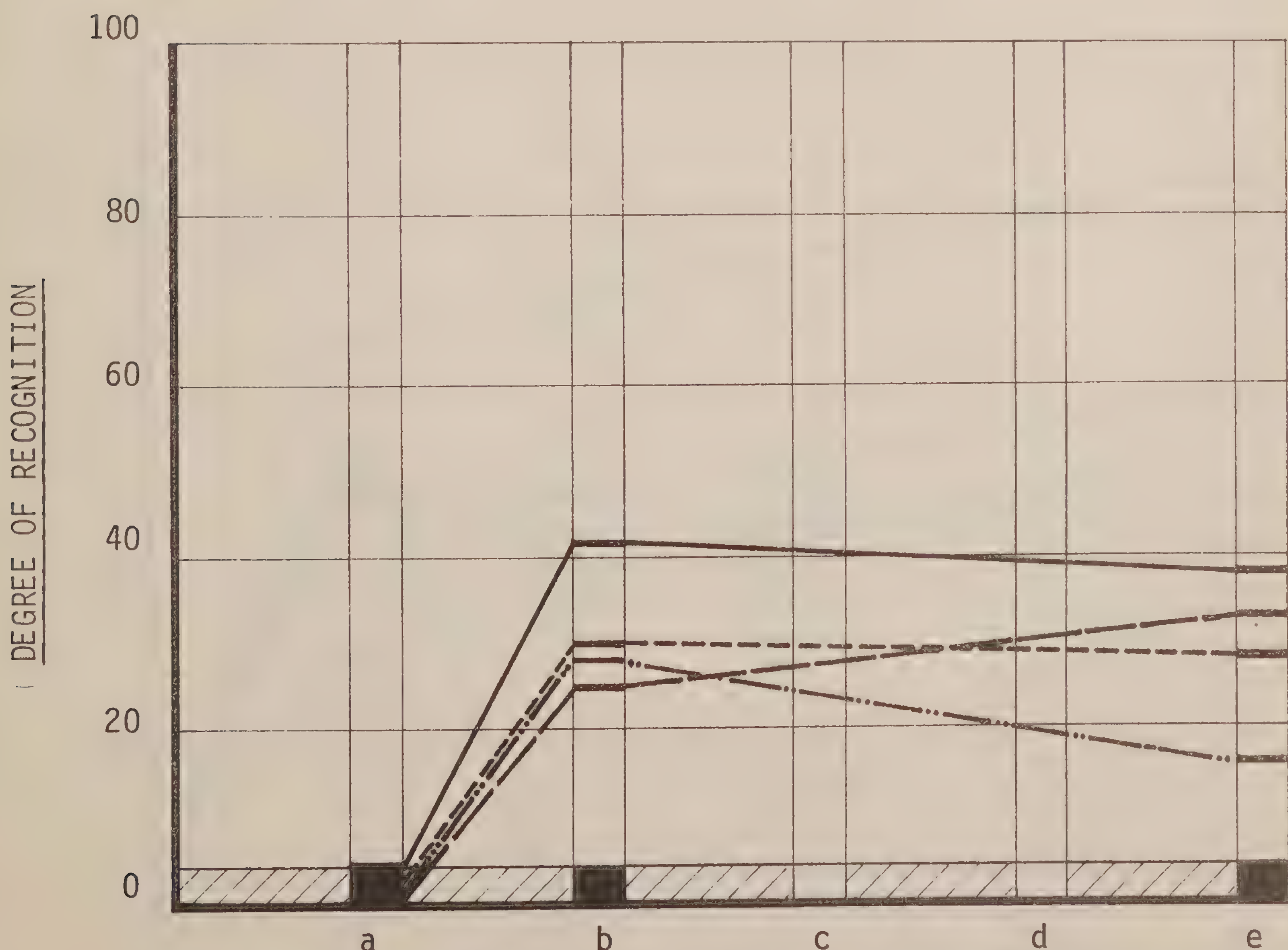


RELATIVE RECOGNITION OF AUDIBLE DIFFERENCE BETWEEN "DONT WALK" AND
"WALK" SIGNALS AT +10dB re 0dB LEVEL OF BACKGROUND NOISE

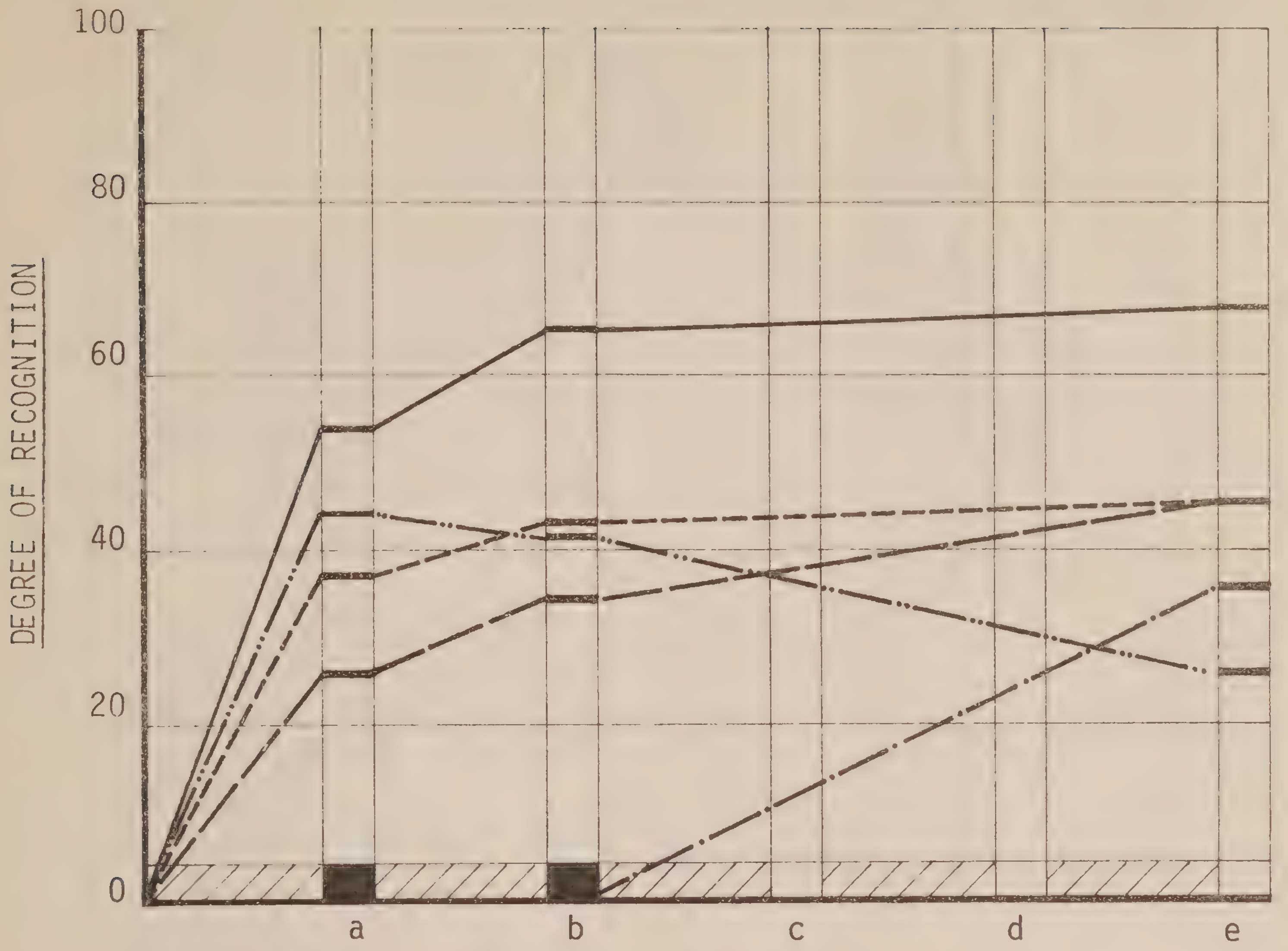
Figure No. 18



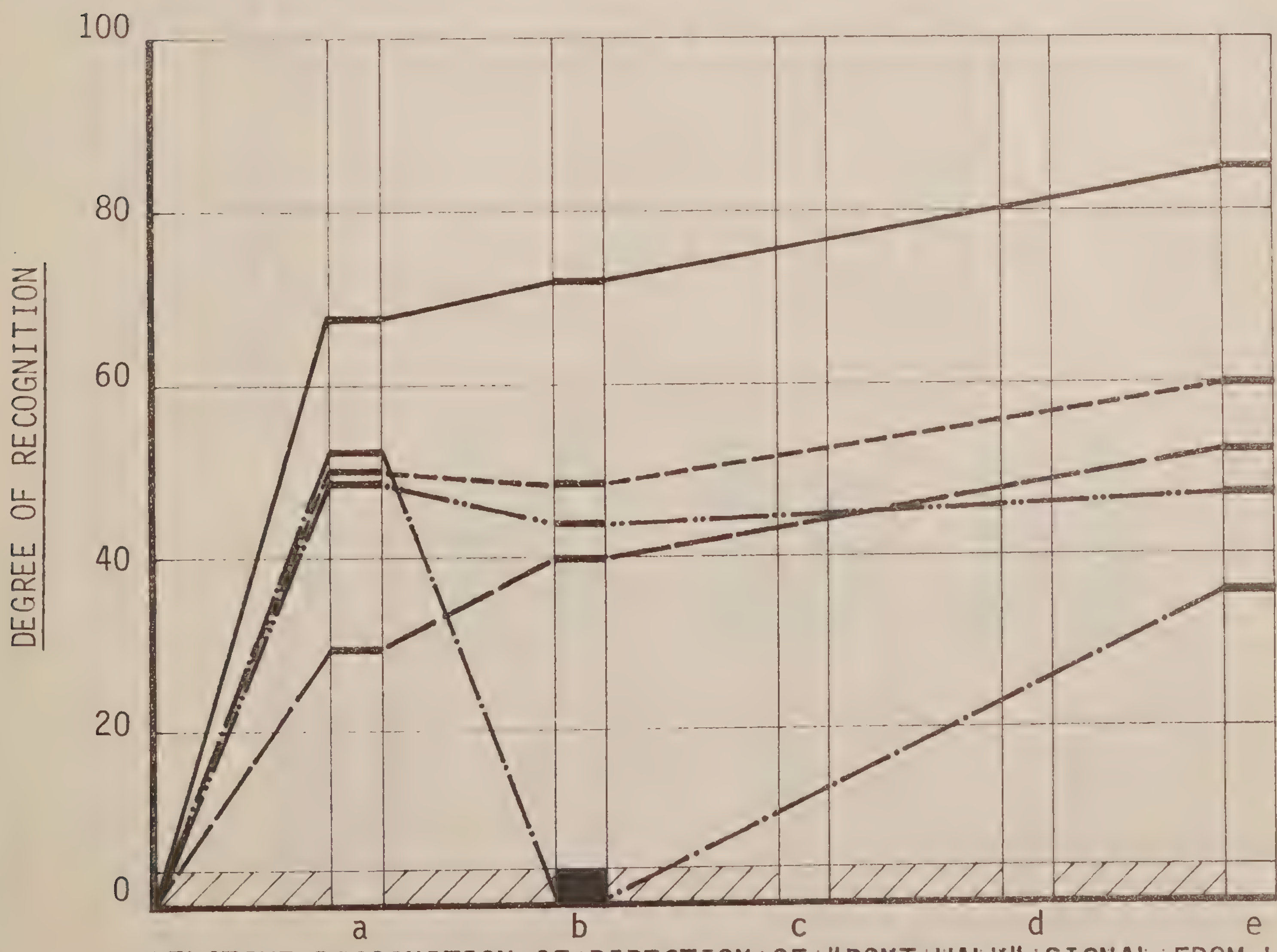
RELATIVE RECOGNITION OF DIRECTION OF "DONT WALK" SIGNAL FROM LEFT AND RIGHT HAND SIDE OF STAGE (NO BACKGROUND TRAFFIC NOISE)



RELATIVE RECOGNITION OF DIRECTION OF "DONT WALK" SIGNAL FROM LEFT AND RIGHT HAND SIDE OF STAGE PLAYED AT -10 B LEVEL OF BACKGROUND TRAFFIC NOISE



RELATIVE RECOGNITION OF DIRECTION OF "DONT WALK" SIGNAL FROM LEFT AND RIGHT HAND SIDE OF STAGE PLAYED AT 0dB LEVEL re 0dB LEVEL OF BACKGROUND TRAFFIC NOISE



RELATIVE RECOGNITION OF DIRECTION OF "DONT WALK" SIGNAL FROM LEFT AND RIGHT HAND SIDE OF STAGE PLAYED AT +10dB LEVEL re 0dB LEVEL OF BACKGROUND TRAFFIC NOISE

Appendix No. 2
to Report No. 2413-1-76

		Swedish Ticker Unit		1khz Square Wave Tone Burst		1kHz Sine Wave Tone Burst		500Hz Square Wave Tone Burst		500Hz Exponentially Decaying Sine Wave	
		Dont Walk	Walk	Dont Walk	Walk	Dont Walk	Walk	Dont Walk	Walk	Dont Walk	Walk
Motivation and Acceptance	Blind	60	-	67	65	40	-	23.5	40	41	60
	Sighted	24	-	44	5	40	-	6	4	51	61.5
Audibility	Blind (good hearing)	61	-	61	33	25	-	36	17	19	35
	Blind (poor hearing)	29	-	42	9	5	-	18	11	5	26
Discrimination		Dont Walk/Walk		Dont Walk/Walk						Dont Walk/Walk	
	Blind (good hearing)	53		42						60	
	Blind (poor hearing)	37		28						40	
Localisation		Left/Right		Left/Right						Left/Right	
	Blind (good hearing)	47		58						63	
	Blind (poor hearing)	22		34						43	

SUMMARY OF RESULTS

The results table for motivation, acceptance and audibility shows a strong preference for the 1kHz square wave tone burst as the "dont walk" signal and the 500Hz exponentially decaying sine wave as the "walk" signal.

The discrimination test shows a slight preference for the 500Hz exponentailly decaying signal.

The localisation test showed a preference for the 500Hz exponentially decaying signal with the 1kHz square wave tone burst a close second.

TESTS AT THE ROYAL BLIND SOCIETY

Two prototype pedestrian push buttons were constructed with an electro-mechanical transducer driving the face plate. The electronic control unit was also constructed to drive these two push buttons in either the "dont walk" or the "walk" mode. This system was then set up on the premises of the Royal Blind Society at Burwood.

The two pedestrian push buttons, mounted on metal posts, were positioned so as to form a typical corner of an imaginary intersection. A tape recorder was also set up to provide suitable masking background noise. The frequency spectrum of this noise was shaped so as to closely represent typical traffic noise without cyclic variation which would provide undesirable audible cues to blind subjects.

The test sequence provided for positioning a blind person in front of one of the pedestrian push buttons and allowing him to briefly familiarise himself with both the "dont walk" and "walk" signals. The blind person was then positioned 6.5m away from the imaginary intersection, as shown in the appended floor plan. He was instructed to move forward and select the pedestrian push button for the straight ahead direction with both push buttons operating in the "dont walk" mode. Once the correct push button was selected a "walk" signal was presented on the other push button to test for negative reactions and then the "walk" signal was presented on the correct push button.

The subjects' movements were noted firstly in locating the correct push button and secondly their response to the "walk" signal. At the completion of the test the subject was initially asked to comment on the signals. The subject was then asked to point directly to each pedestrian push button which was operating in the "walk" and "dont walk" mode. The results of these tests showed a high degree of accuracy in locating the correct pedestrian push button and responding to the correct signal.

The unsolicited comments and the results obtained during this test session correlated well with the results obtained in the previous test. The results did however show that blind people wearing two hearing aids cannot make full use of the localisation characteristics of this system and no further modifications can be incorporated in this system to resolve that problem.

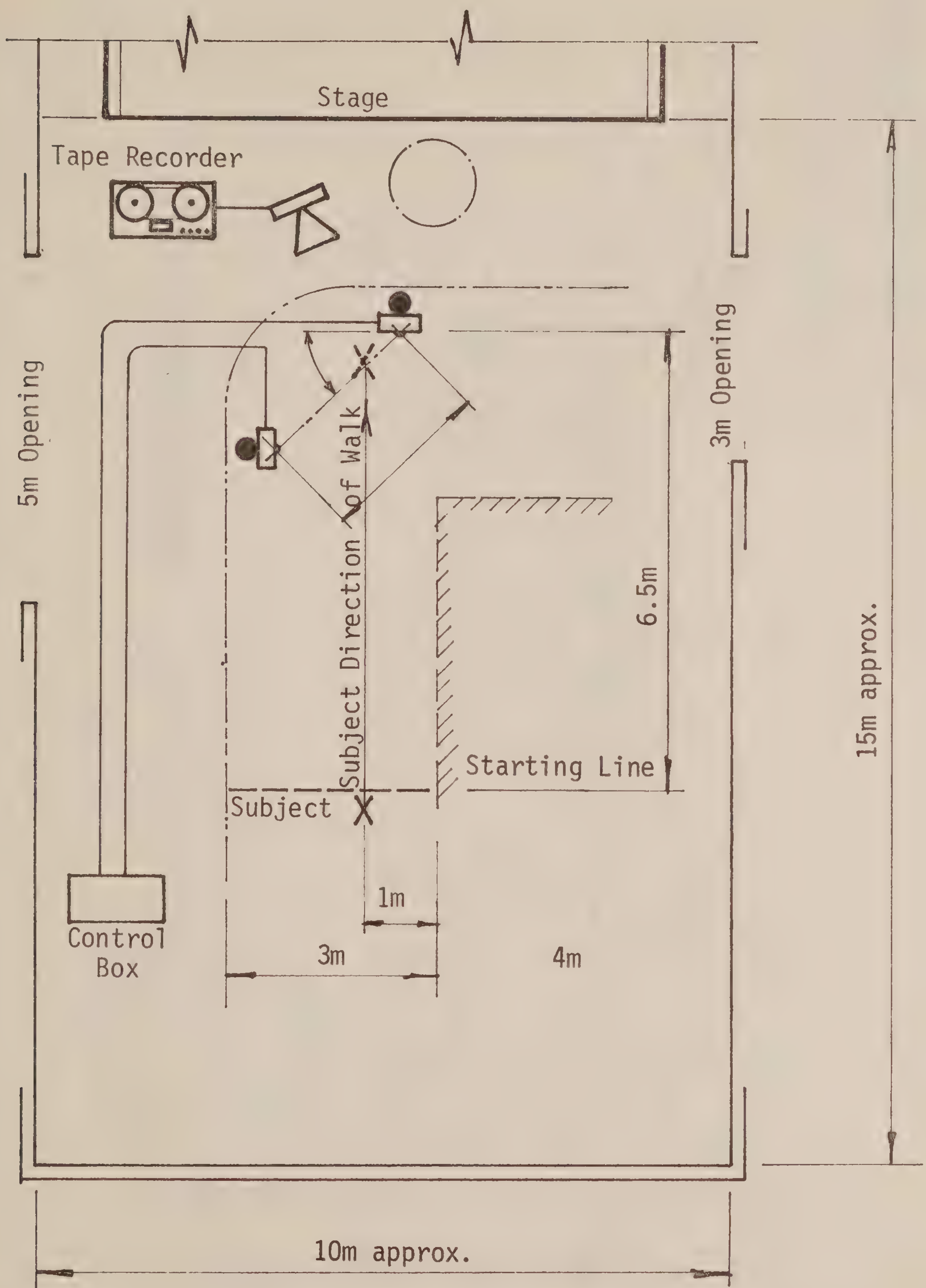
A problem was also encountered by a blind person with a guide dog and this was not due to the system but rather a problem of co-ordination between the guide dog and the man.

The prototype audio-tactile pedestrian push button system as used in this test was very favourably received by all of the blind subjects as well as by the mobility instructors present during the tests.

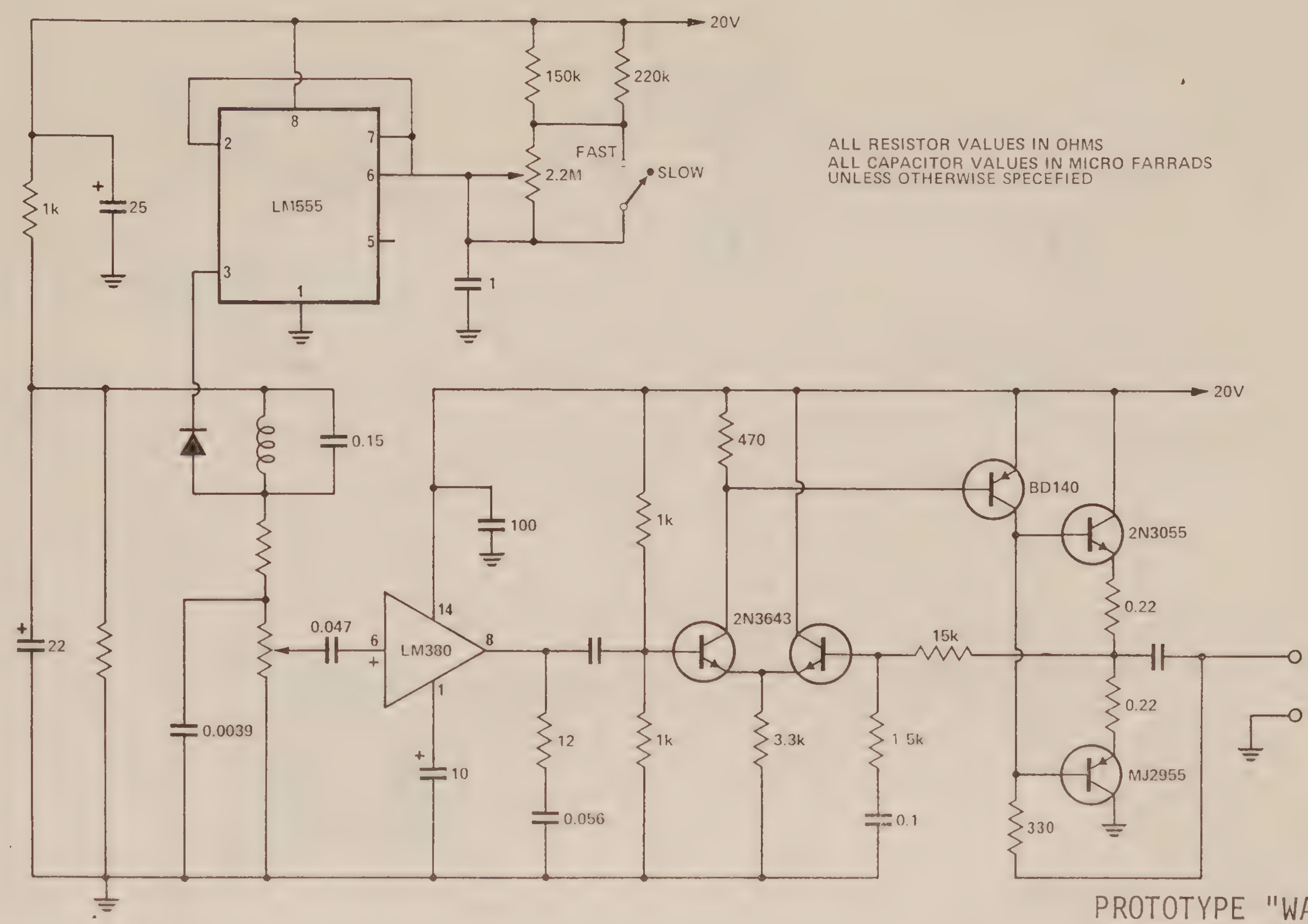
Figure No. 20

FLOOR PLAN OF SUBJECTIVE TESTS USING TWO

AUDIO VIBRO-TACTILE PROTOTYPE PUSH BUTTONS



(All broken lines are imaginary only)

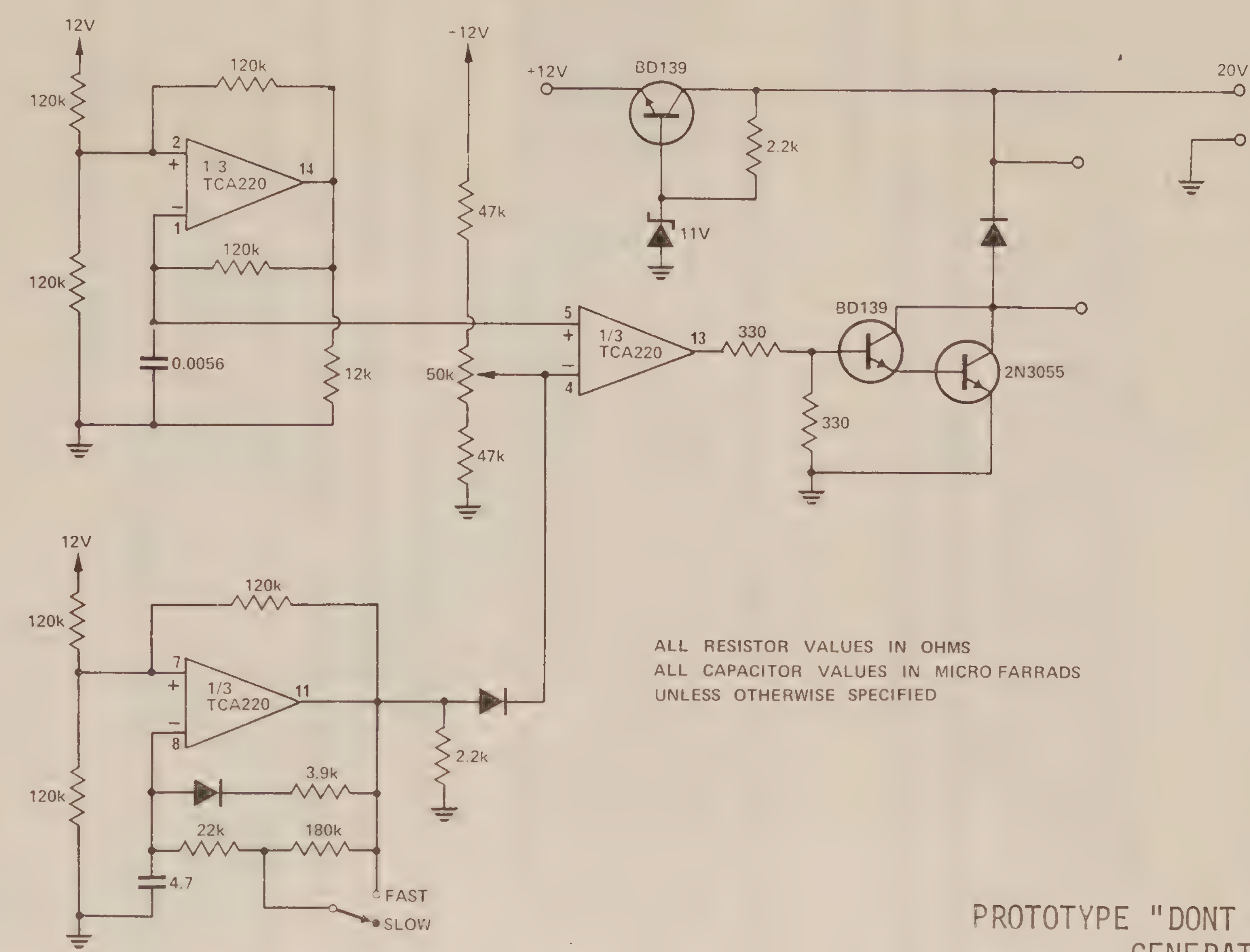


ALL RESISTOR VALUES IN OHMS
ALL CAPACITOR VALUES IN MICRO FARRADS
UNLESS OTHERWISE SPECEFIED

PROTOTYPE "WALK" SIGNAL
GENERATOR AND AMPLIFIER

LOUIS A. CHALLIS & ASSOCIATES
158 QUEEN ST WOOLLAHRA 2025, N.S.W. Tel. No. 32 4963

Scale		Sheet	of
Checked		Drawn	
Material		Approved	
Title	Drg. No.	Finish	
		2413-76-1	



ALL RESISTOR VALUES IN OHMS
ALL CAPACITOR VALUES IN MICRO FARRADS
UNLESS OTHERWISE SPECIFIED

PROTOTYPE "DONT WALK" SIGNAL GENERATOR

LOUIS A CHALLIS & ASSOCIATES

Used on

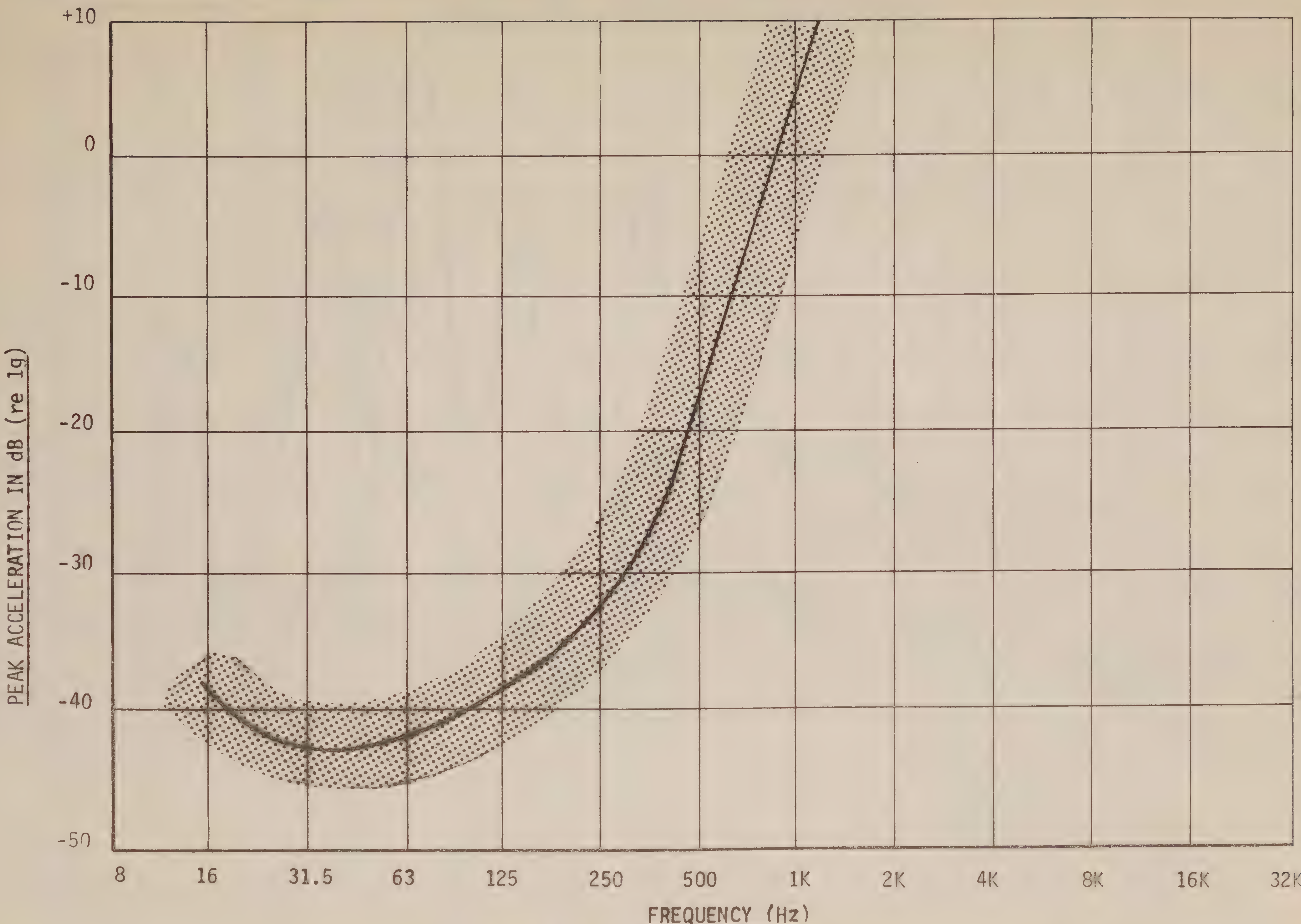
2413-76-2

ACOUSTIC AND VIBRATION CHARACTERISTICS OF TRAFFIC AIDS CURRENTLY AVAILABLE FOR BLIND PEDESTRIANS

Acoustic measurements on currently available audible aids for blind pedestrians were carried out in both the frequency and time domain. No distinct optimal frequency characteristics could be isolated between the individual signals tested. An examination in the time domain showed that short duration, impulsive sounds, had the most suitable characteristics for an audible aid.

Further tests were then conducted on the vibro-tactile aids to determine their frequency characteristics in terms of peak acceleration. The results of this test are shown in the appended graph. A further graph shows the typical fingertip vibration threshhold levels, thus allowing ready evaluation of the merits of the individual vibro-tactile aids.

An inspection of Figure No.22 shows that where the device produces narrow frequency bands of energy below 1kHz they appear to provide characteristics of the more successful vibro-tactile devices. The Swedish ticker unit, however, produces broad band energy above 1kHz which results in low effective displacement levels and hence does not optimise the characteristics of high level, low frequency energy which are most suitable for a good vibro-tactile device.

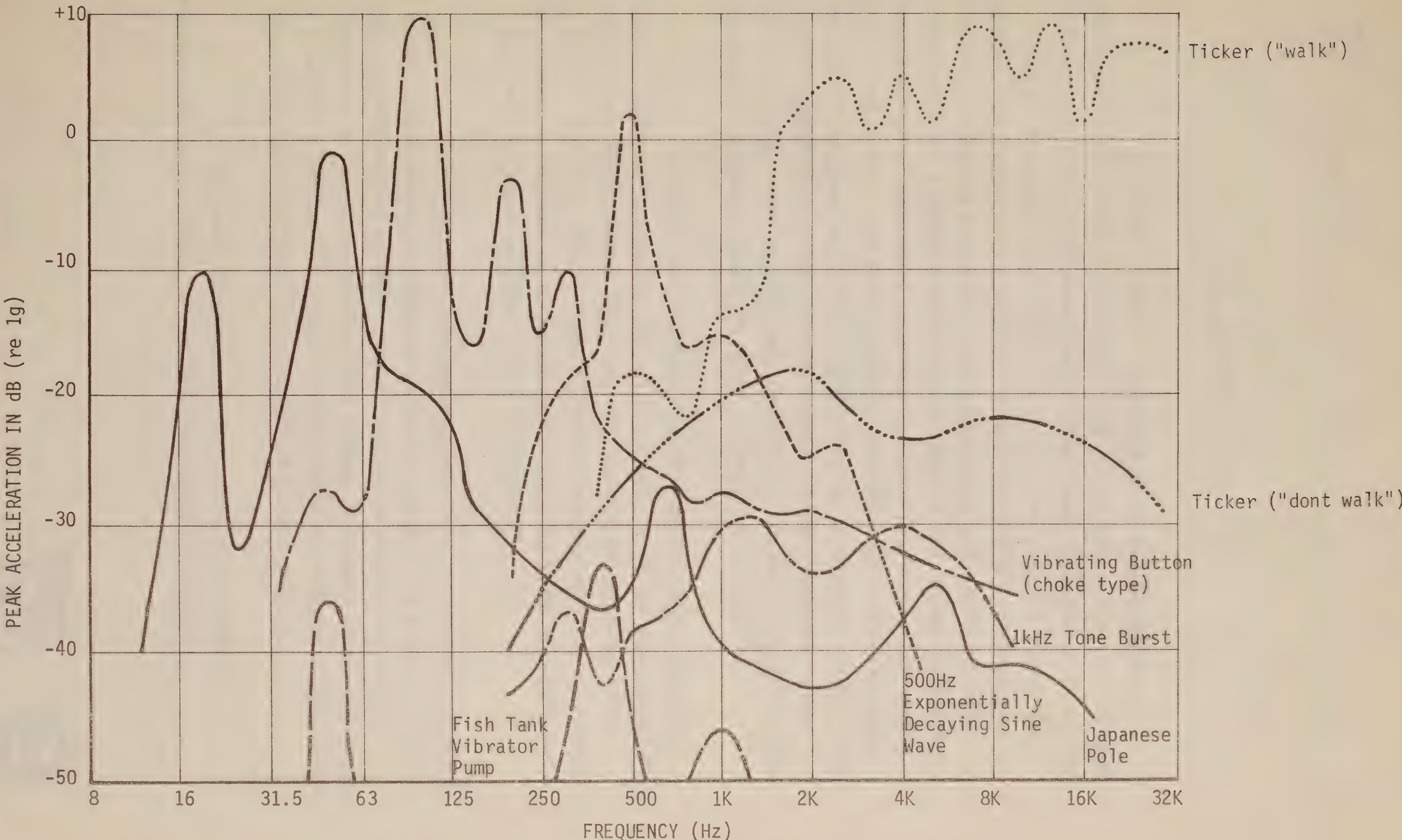


FINGERTIP VIBRATION THRESHHOLD LEVELS

(See Reference 35)

GRAPH SHOWING ACCELERATION VERSUS FREQUENCY OF TYPICAL TRA⁻FIC INTERSECTION - VIBRO-TACTILE AIDS FOR BLIND

Figure No. 22



FINAL PROTOTYPE SYSTEM

The final prototype consisted of an electro-mechanical transducer fitted within a pedestrian push button box of the type currently used in N.S.W. This electro-mechanical transducer is mechanically coupled to the front escutcheon plate which in turn re-radiates the acoustical energy. This system thus provides an electro-acoustical transducer which is fed by a combined electronic signal generating and control circuit. This circuit utilises a square wave generator which is fed through a tone burst gate providing a 1kHz square wave tone burst for the "dont walk" signal. This is fed through a 50 watt power amplifier and then to the transducer. The gain of the power amplifier is controlled by an automatic level control circuit consisting of an electret microphone, a 400Hz low pass filter and an automatic level control amplifier with a 10 minute integration time. This overall system utilises 240 Volts to power the DC supplies.

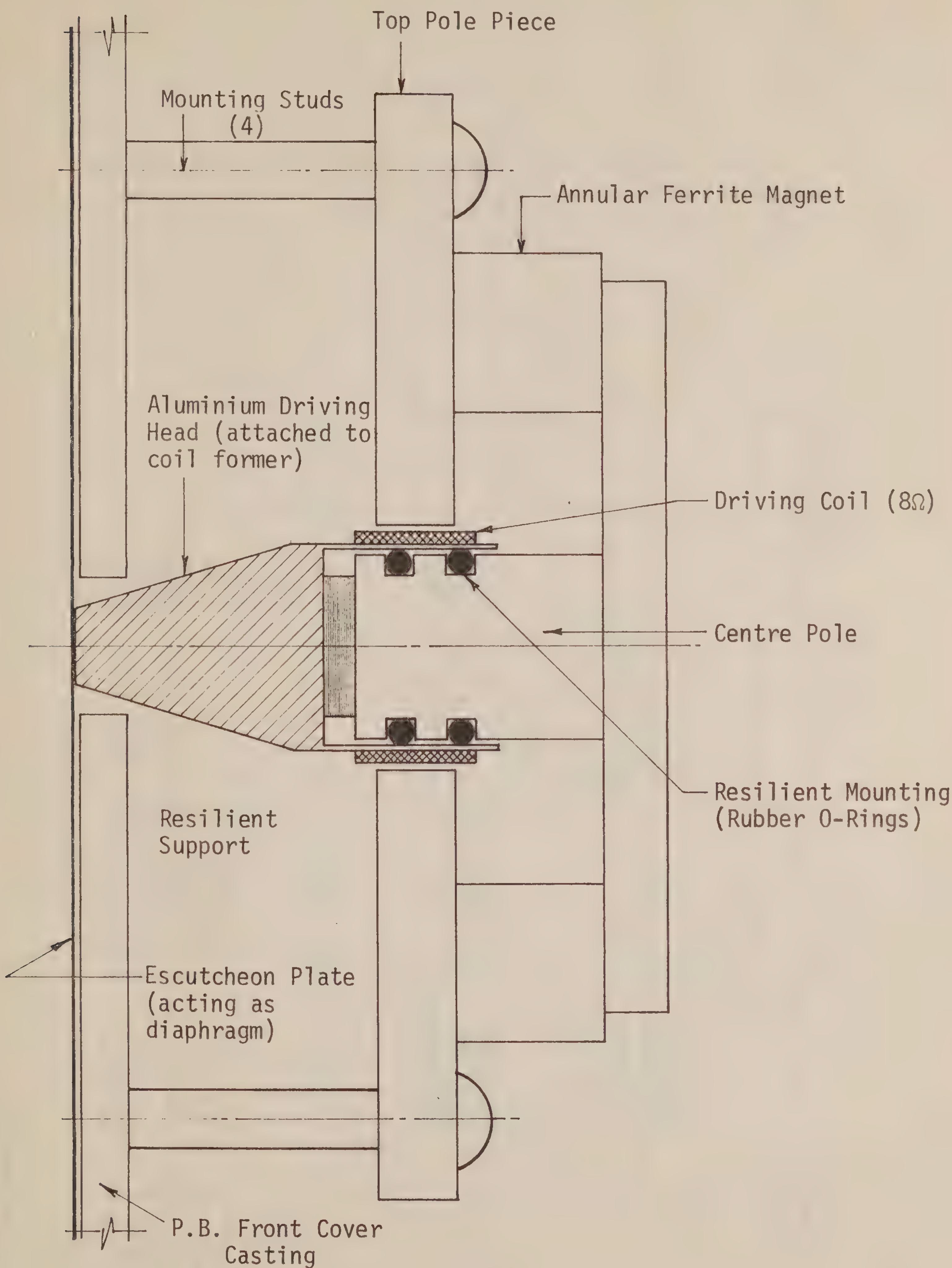
A signal line is taken from the "walk" lantern and this provides power for generating the "walk" signal. With the application of power to the "walk" lantern the "dont walk" signal is gated out whilst an initial frequency decaying tone of 50 milliseconds duration is produced. This signal is followed by an exponentially decaying 500Hz sine wave which is then fed via power amplifier to the transducer.

This exponentially decaying sine wave is produced by pulsing a tuned circuit which is allowed to naturally decay. The whole electronic signal generating and control circuit is built on one printed circuit board which is wired through plugs and sockets to a power supply and housed in a weather-proof box. This box, together with the pedestrian push button unit, constitutes the total system described in this project.

The special transducers utilised were developed by Magnavox (Australia) Pty. Ltd. to meet the system requirements.

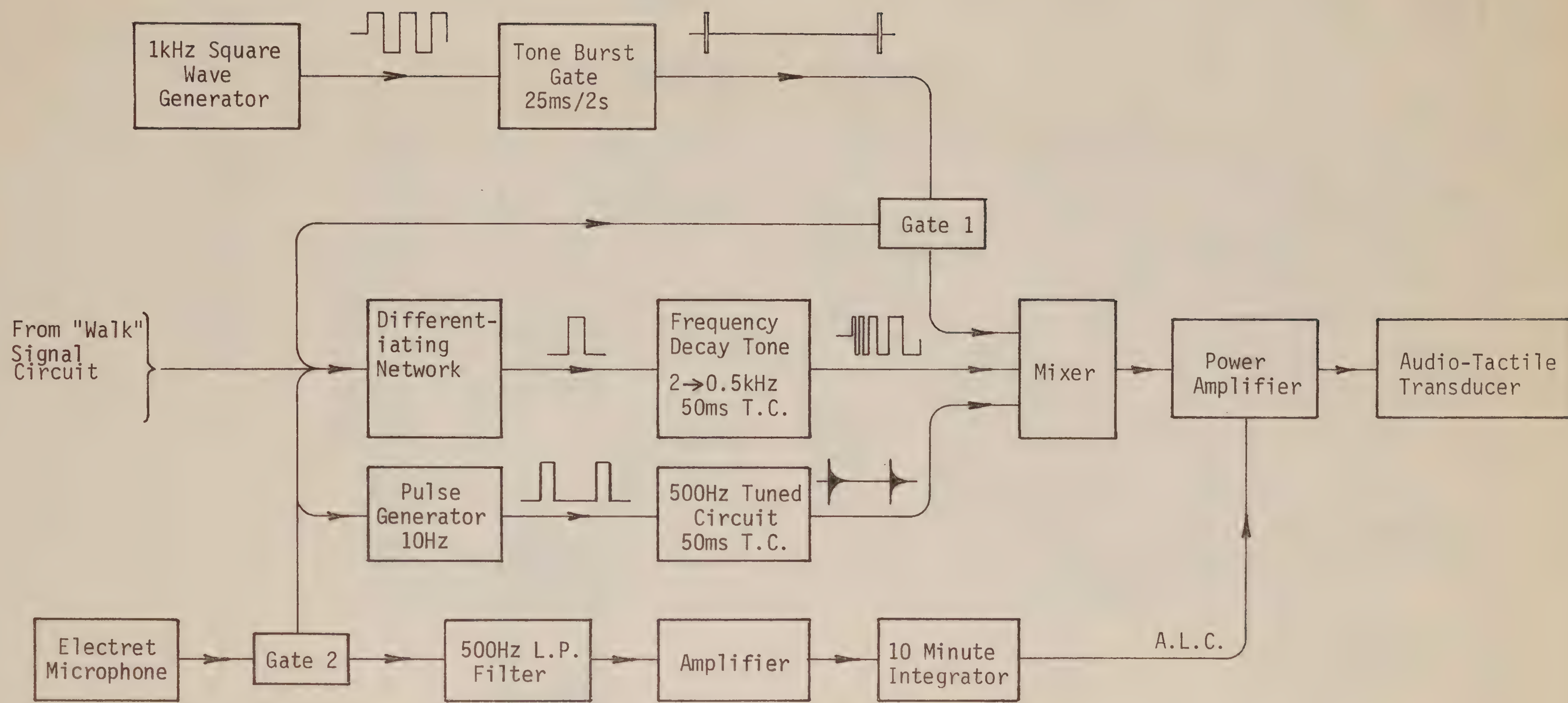
Figure No. 23

CROSS-SECTION OF AUDIO-TACTILE TRANSDUCER

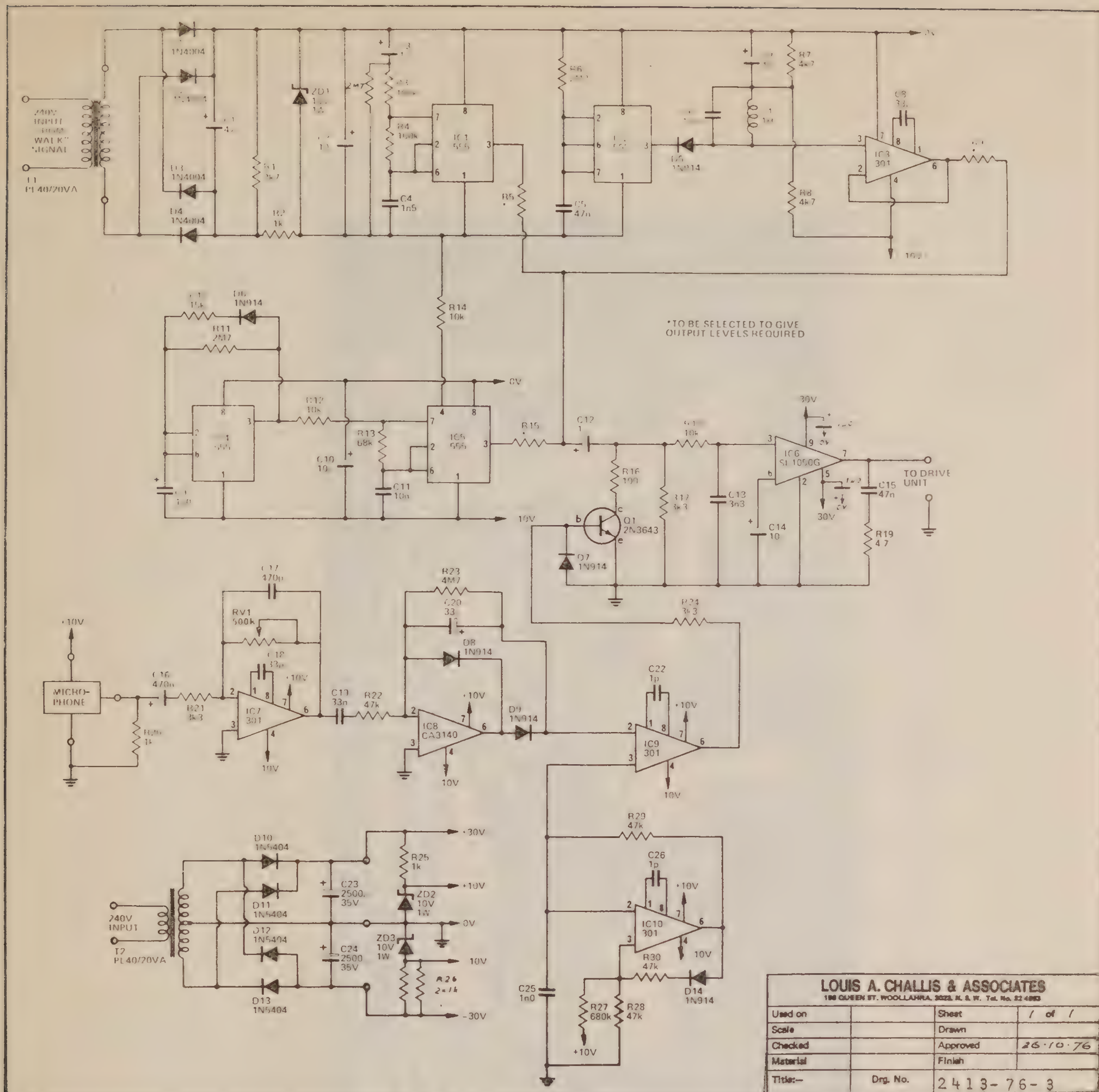


(not to scale)

Figure No. 24



FUNCTIONAL BLOCK DIAGRAM OF AUDIO-TACTILE PEDESTRIAN TRAFFIC SIGNAL SYSTEM

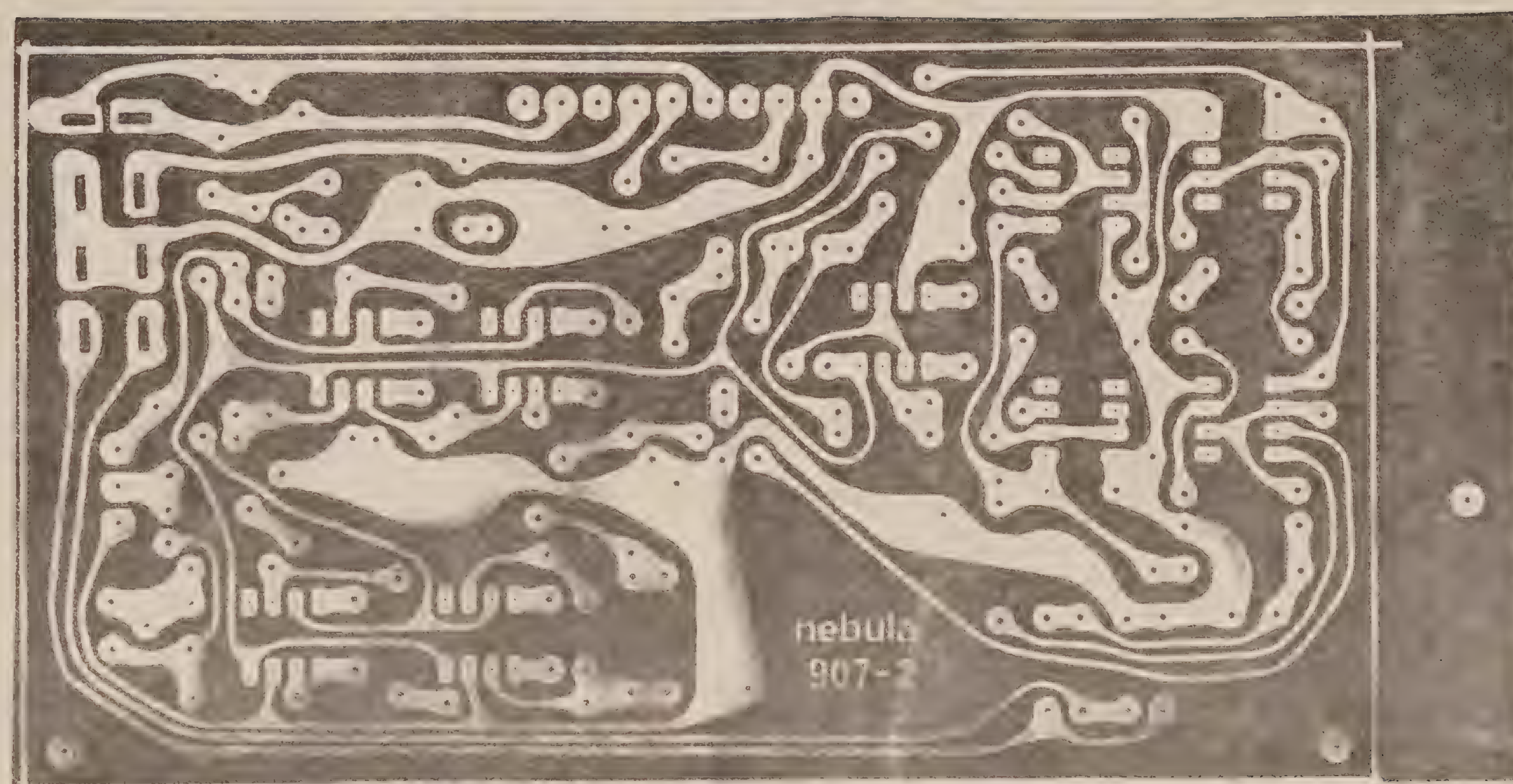


AUDIO-TACTILE SIGNAL FINAL PROTOTYPE

ELECTRONIC CIRCUIT

Microphone : Electret type ECM1001

Drive Unit : Magnavox 8Ω Type A.



PRINTED CIRCUIT UTILISED IN PROTOTYPE SYSTEM

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